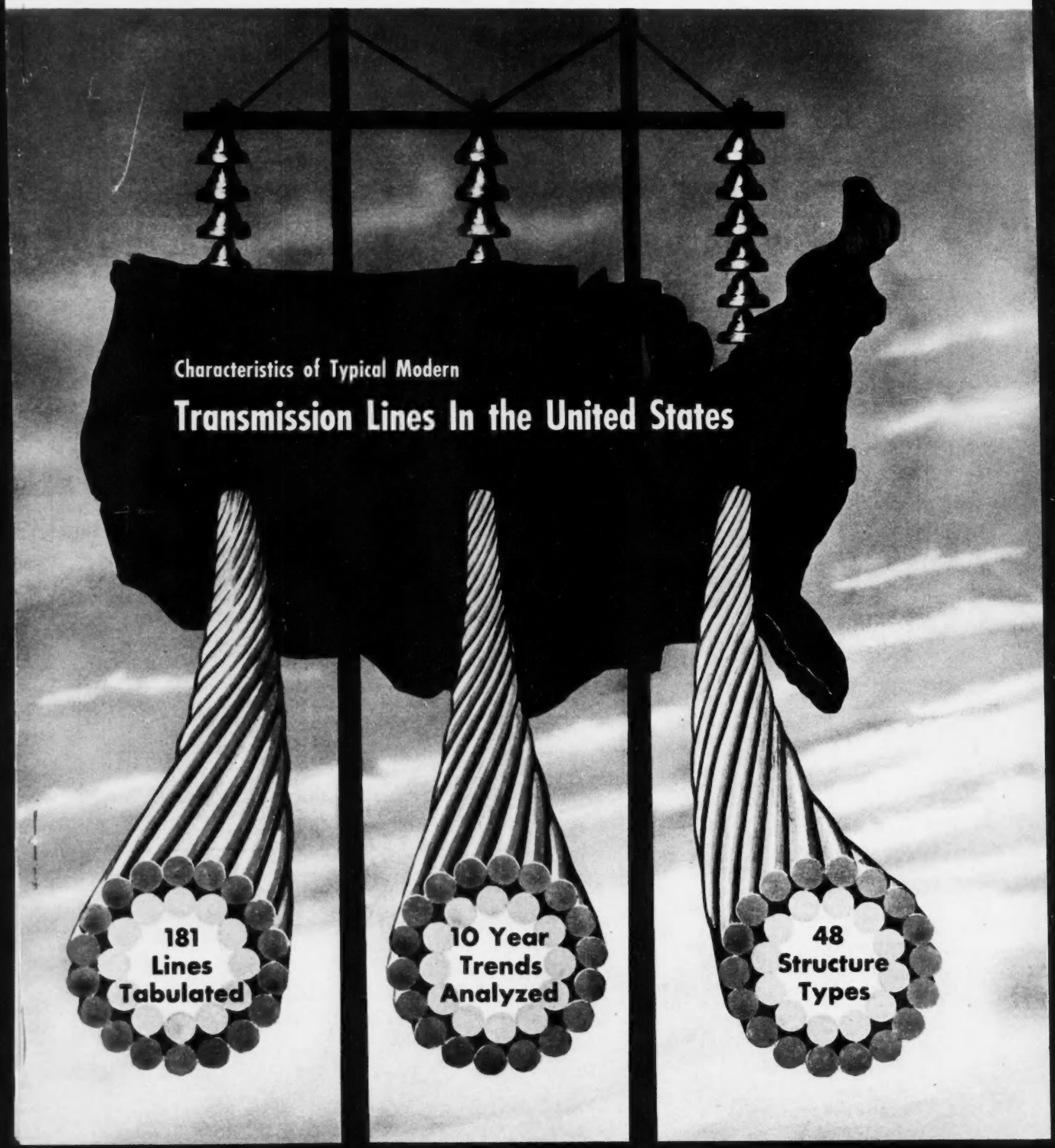
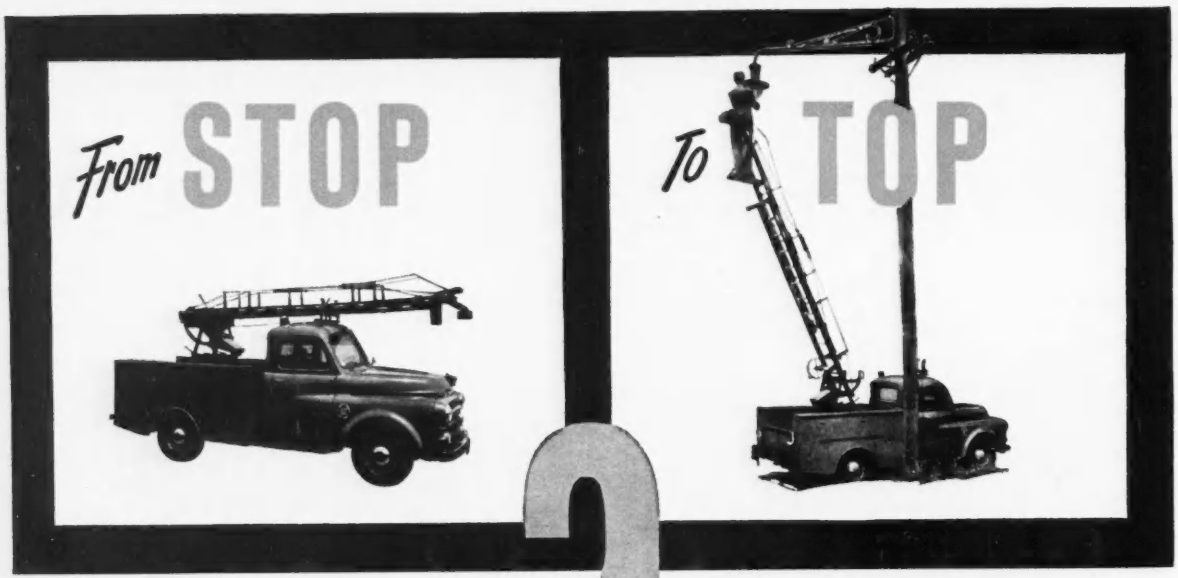
AUGUST 24, 1953

Electrical World

Price 35 Cents

A McGRAW-HILL PUBLICATION


Characteristics of Typical Modern
Transmission Lines In the United States
181 Lines Tabulated
10 Year Trends Analyzed
48 Structure Types



IN 3 EASY STEPS

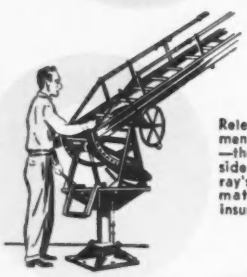
with the Murray Crows'nest

REGISTERED TRADE MARK

1

JUST A SLIGHT PRESSURE

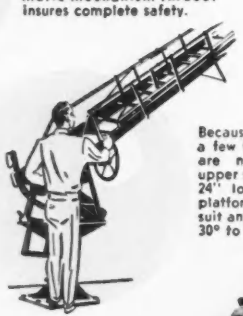
Pull out the handle, press down. That's all that's needed to release ladder from riding position and raise it to the desired inclination. Husky spring action does most of the work. Release handle to lock the ladder.



2

ROTATE

Release locking arrangement. Rotate full 360° easily—there is a handle on each side for convenience. Murray's exclusive semi-automatic mechanism thruout insures complete safety.



3

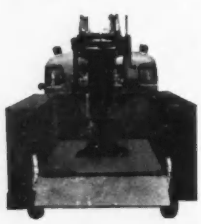
EXTEND

Because of large drum, only a few turns on the windlass are necessary to extend upper section of ladder. The 24" long flat floor of the platform is adjustable to suit any of the inclinations—30° to 72°

LEAVES PLENTY OF FLOOR SPACE

Even on low priced pick-up trucks, the Murray Crows'nest leaves the absolute maximum in standing and loading space. Rotation at 37½" is above usual height of cabinets.

In the riding position, the Murray Crows'nest snuggles close to the top of the cab. Low center of gravity keeps the truck in good balance.



Your men can do more jobs per day because operation of the Murray Crows'nest is quicker, easier and less fatiguing. Each of the steps — inclination, rotation and extension — is easy-flowing and effortless. The reason is simple — Murray engineers have designed the Crows'nest to do most of the work itself. Every part is in perfect balance so that only a slight pressure is needed to start each action.

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1250 Atlantic Avenue, Brooklyn 16, N. Y.

Send specifications, drawings, mounting instructions and quote on:

29'..... 32'9..... 36'8.....
Pedestal Style Crows'nest

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

.....

Murray®

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Service Entrance and Meter Equipment • Magnetic Hydraulic Circuit Breakers
Safety Switches (Types A, C & D). • Current Limiting Reactors • Utility Specialties

Catching Up on Back Work

The "Roaring Twenties" add up to a significant chapter in America's nostalgic past. It was a time of enthusiasms of various natures—most of them dedicated to fun. Amidst all the revelry, however, much serious and lasting work was done. An example of such a monument is the survey of transmission lines in the country that Electrical World editors conducted in 1927 and then repeated two years later.

For a quarter of a century the 1929 effort has remained as the answer to a steady trickle of requests made for EW's "latest" survey of transmission lines. That situation has been remedied with this issue.

New Monument . . . From pages 121 to 150 appear the results of the labors of 10 editors, started at the beginning of the year. It covers replies received from 80 utilities and government power agencies, and embraces 281 lines of 100 kv or higher, stretching 12,850 miles—two round trips across the country.

Detailed is information on all aspects of transmission systems: types of structures and structural reinforcements, conductors, ground wires, insulators, lighting protective devices, regulating equipment, relaying, carrier, microwave—in short, a symposium of the significant design characteristics in the power transmission field.

Rich Harvest . . . To get its information EW went to the obvious source—the utilities. Questionnaires were sent out, field trips made, countless hours were spent on the phone, and even more hours checking and rechecking the involved data and tables. Supervising the project was A. E. Knowlton, Senior Associate Editor, who joined EW within a few months after the last transmission survey was made in 1929.

The result is the answer to a T&D engineer's dream: A concise, up-to-date, accurate synopsis of every important high voltage transmission line in the United States—a record that will be remembered and referred to for years to come.

Electrical World

Published for 79 years for those engaged in the business of generating, transmitting, distributing, or applying electric power

Vol. 140 No. 8 — August 24, 1953

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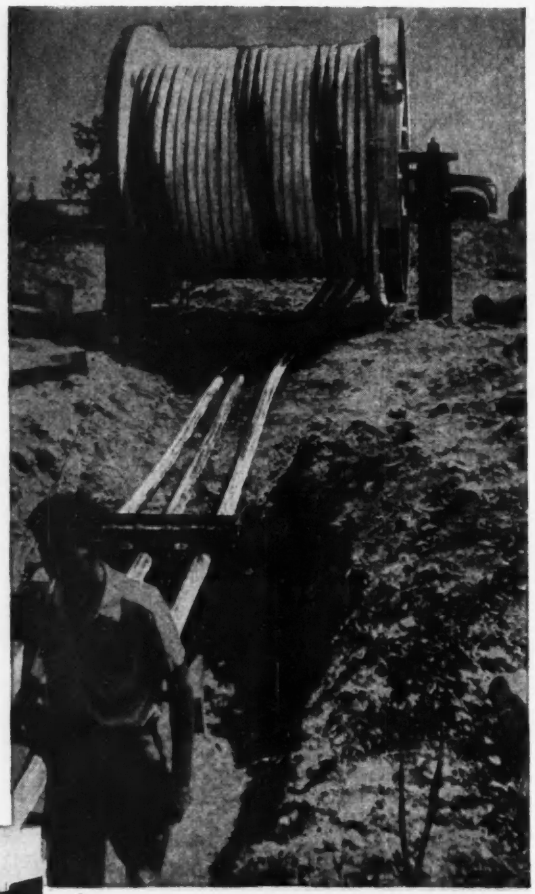
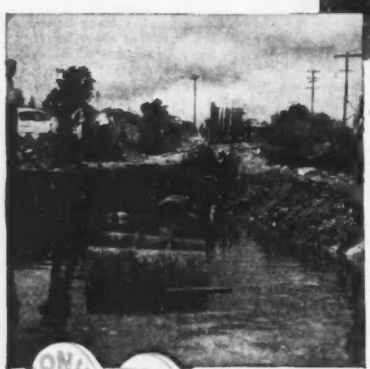
ingenious methods simplified laying of three Okonite submarine cables

Three 12,000-volt Okonite submarine cables, each 830 feet long were installed as outgoing power lines across the Colorado River for a new addition to the Municipal Power Plant of the City of Austin, Texas. Some of the details of this unusual installation are given below:



To simplify the laying, the three lengths of cable were paralleled on one steel reel 10 feet in diameter. Because of the shallow water and the great weight of the reel and cable (over 46,000 lbs.) the usual method of mounting the reel on a barge was impractical. Instead, the reel was cradled on a concrete foundation and the cables were passed through a feeder mechanism to provide proper spacing.

The three cables were attached to a special steel bridle weighing over 400 pounds, so they could be pulled at the same time. Two 50-gallon oil drums were used to float the bridle.



Oil drums spaced 10 feet apart were also used to float the cables. When the cables had been pulled across the river they were lowered into a trench dug by dragline five feet below the bed of the river. The submarine cables were then spliced to Okolite-Okoprene cables in manholes at each end of the submarine line run.

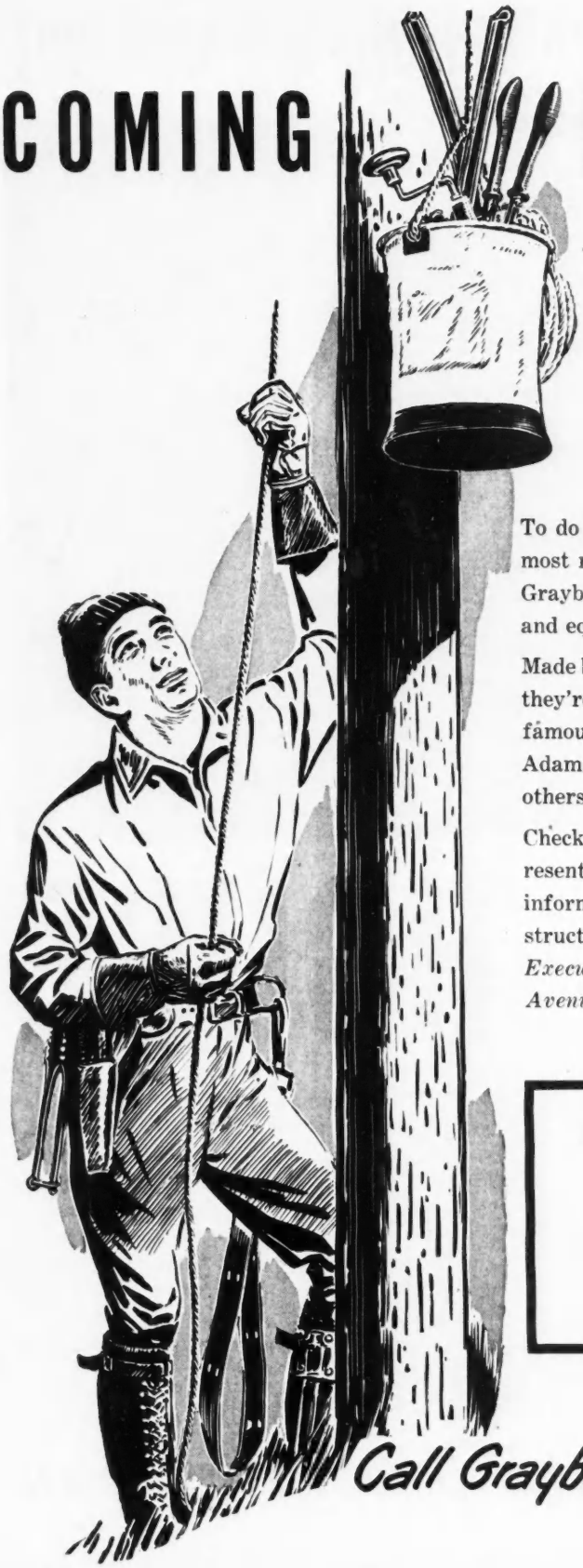
Tough and unusual cable installations have a way of turning out to be Okonite. We'd be glad to send you the full facts on *this* job—or to assist in helping you to solve a particular cable problem of your own. Just write The Okonite Company, Passaic, N. J.

CONSULTING ENGINEERS: Burns & McDonnell Engineering Co., Kansas City, Missouri. ELECTRICAL CONTRACTOR: W. K. Jennings Electric Co., Austin, Texas. JOBBER: Priester Supply Co., Dallas, Texas.

OKONITE insulated cables

OKONITE 75

COMING RIGHT UP!



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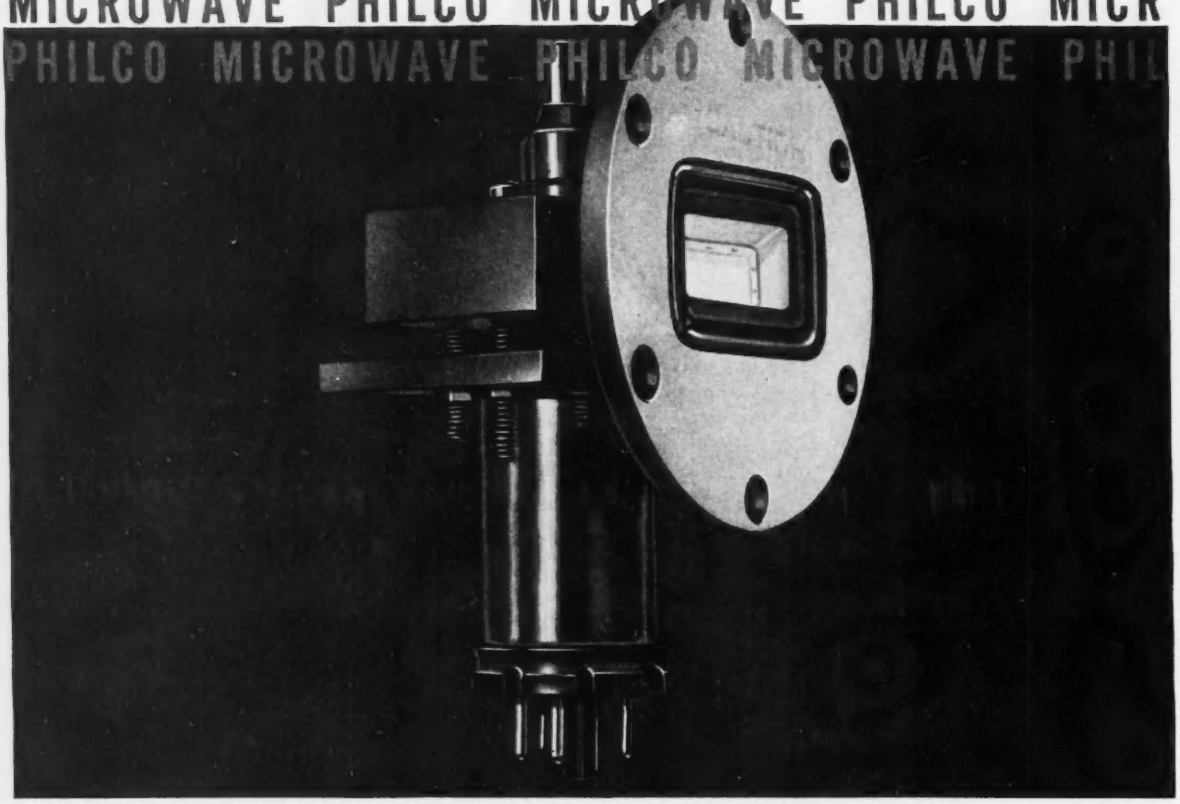

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With the new Grinnell Model R Constant Support, the pipe, its covering and contents, are supplied mathematically perfect support in all positions of travel. In addition, constant support is maintained throughout the full range of field adjustability.

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FEATURES OF GRINNELL MODEL R CONSTANT SUPPORT HANGER:

- 3 frame sizes provide maximum travel of 4 inches, 8 inches and 12 inches respectively to accommodate all loads from 48 to 9,304 pounds
- Non-resonant
- Anti-friction needle bearings keep friction to a minimum
- Individually calibrated before shipment to support exact load specified
- Requires less head room
- Can be bolted directly to the building structure or suspended by either single or double rods

SEND FOR DETAILED CATALOG ON NEW GRINNELL MODEL R CONSTANT SUPPORT HANGER

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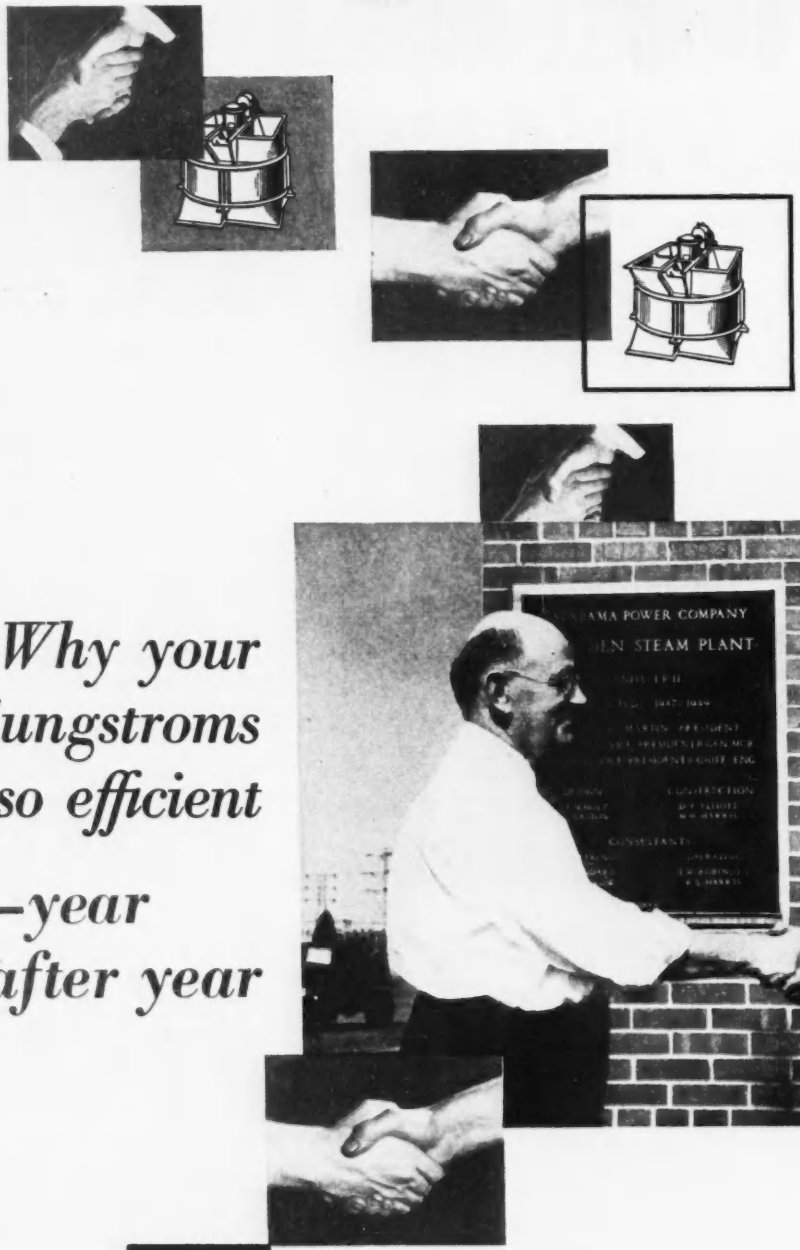

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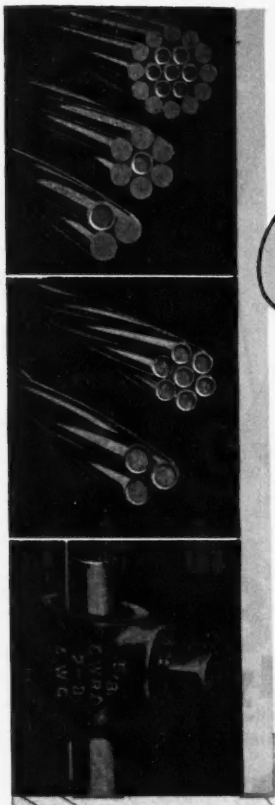

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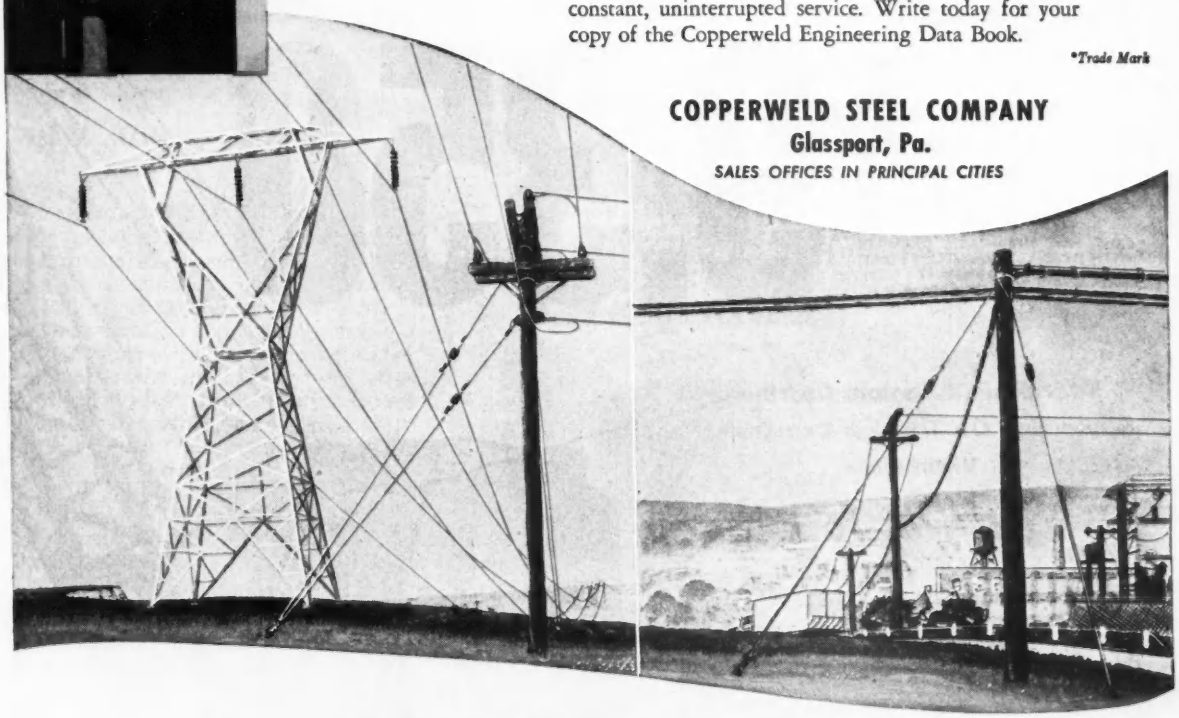

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Price Subject to Change

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WORLD'S LARGEST PRODUCER OF TRUCK-CRANES AND EXCAVATORS

...JUST LOOK WHAT YOU GET!

Model

C-35

5 TON — ⅜ CU. YD.

Available with
9 fast-change attachments:

BACK HOE	CLAMSHELL	MAGNET CRANE
CRANE	SHOVEL	PILE DRIVER
DRAGLINE	GRAPPLE	BACKFILLER

✓ 2-SPEED INDEPENDENT TRAVEL—enables the operator to move at varying speeds, forward or reverse, while operating the front end attachment.

✓ LOW GROUND BEARING PRESSURE—2 pad sizes available. 5 lbs. per sq. in. with 16" pads—3⅓ lbs. per sq. in. with 24" pads.

✓ BIG MACHINE STABILITY—longer, wider tracks—and a low center of gravity gives greater lifting capacity.

✓ HIGH SPEED OPERATION—features immediate acting straight mechanical controls, easy positive braking action, fast line and swing speeds.

✓ FAMOUS BANTAM FEATURES—power boom hoist, machine cut gears, anti-friction bearings, 4 hook rollers, greater visibility.

✓ 94-INCH OVER-ALL WIDTH—allows the Bantam to be moved from job to job on standard trailers without special highway permits.

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A BRAND NEW CRANE CARRIER CUSTOM BUILT BY A FAMOUS TRUCK MANUFACTURER

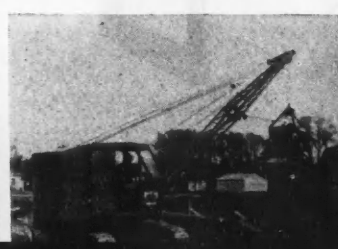
Model T-35 6 TON ⅜ CU. YD.

BACK HOE
Crawler working in solid mud . . . crawls out after trenching with no trouble. High flotation enables Bantam to work in any kind of underfoot conditions—muck, mud, sand, etc.

SHOVEL
Handles up to 100 cu. yds. per hour from stock-pile . . . up to 90 cu. yds. excavating in average material. Automatic dipper trip means quick, effortless dumping. Also available with ½ cu. yd. rehandling bucket.

DRAGLINE
Digs 90 cu. yds. per hour in average material, available with perforated or solid buckets. Ideal for gravel pits, ditch cleanout, cutting new drainage ditches, basement excavations, stock-piling, pits, etc.

CLAMSHELL
Ideal for stock-piling and loading out of stock-pile . . . precision excavating of bell holes, special excavating on pipeline jobs, cleanout of trenches. Handles up to 80 cu. yds. of average bulk material per hour.



NEW

ALLIS-CHALMERS

OIL CIRCUIT BREAKERS

Here's the inside story of recent improvements in this time-proved breaker. This breaker has long been used for outdoor distribution service where safe, reliable operation is a necessity. Now it is even more easily installed and maintained. This means a further reduction in your circuit breaker service costs because of the following features. A-4074

1. New "full view" doors open to expose three sides of operator cabinet—not just one.
2. Gasketed doors make cabinet completely weatherproof.
3. Cabinet is enlarged to house accelerating adjustment mechanism, solenoid operator and connecting linkage. Accelerating spring is easily accessible.
4. Simplified operator and pole unit mechanisms. Fewer parts now used for simplicity — added reliability.
5. Maintenance closing handle can be used from either front or side of control cabinet. This means breaker may be used in confined area.
6. Shielded vitreous enameled space heater provided.
7. Manual trip now located higher on back of cabinet to help prevent accidental tripping.
8. Simplified transformer wiring duct. Removal of single bottom plate of wiring duct exposes continuous transformer leads along full length of duct.
9. Self-aligning tulip and bayonet contacts retained.
10. Contacts are at convenient level — no interference from the frame.
11. Thoroughly proved *Ruptor* arc-interrupting device retained.
12. Easy tank removal! There is no interference from frame.
13. Individual rectangular tanks occupy less space, using less oil and providing best electrical clearances.
14. Tank lifter mounted on back — operated from either side.
15. Grounding pad is stainless steel faced.

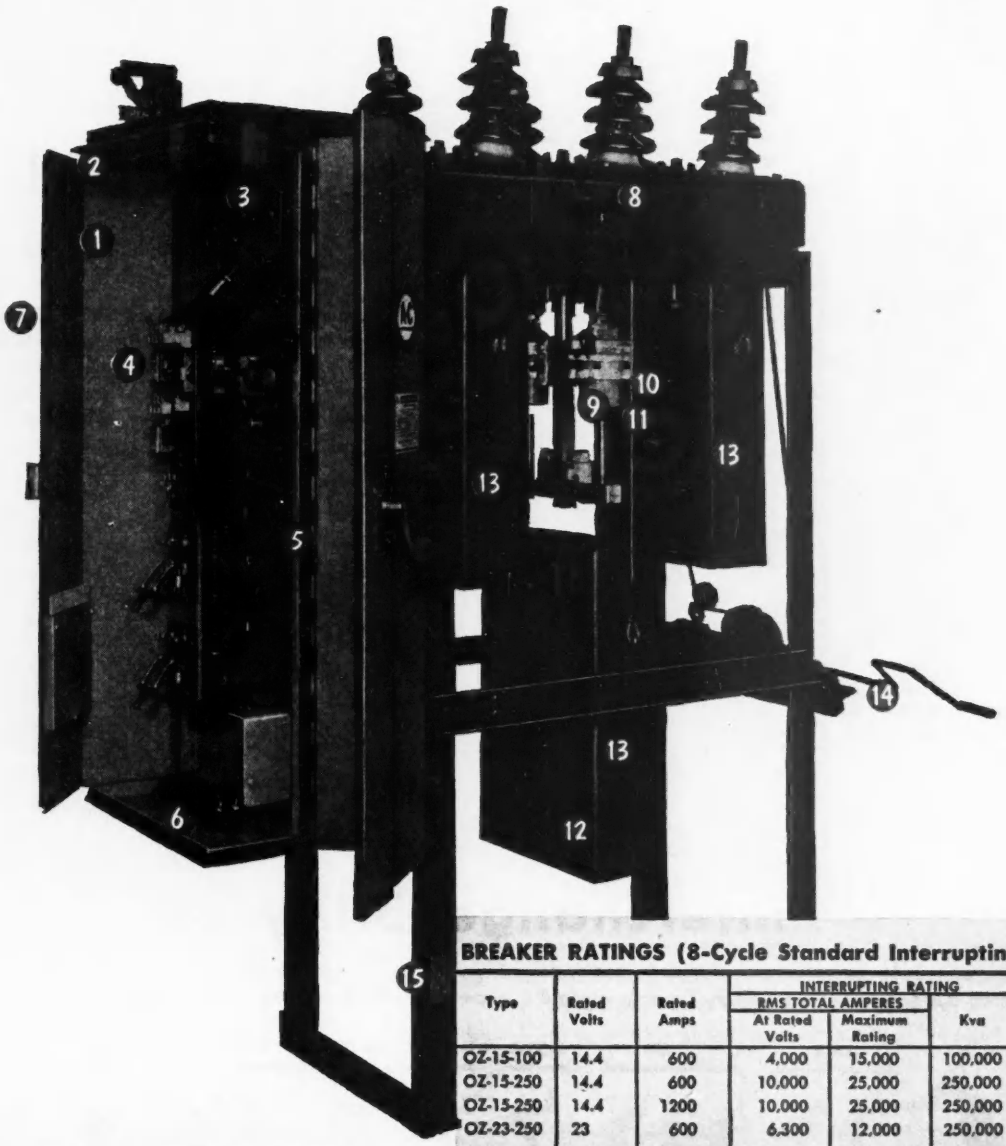
Standard outdoor automatic reclosing relay equipment and cabinet are available.

Ruptor is an Allis-Chalmers trademark.

ALLIS-

Accessibility

For Inspection...Test...Maintenance



BREAKER RATINGS (8-Cycle Standard Interrupting Time)

Type	Rated Volts	Rated Amps	INTERRUPTING RATING RMS TOTAL AMPERES At Rated Volts	INTERRUPTING RATING RMS TOTAL AMPERES Maximum Rating	INTERRUPTING RATING Kva	Weight of Breaker With Oil (lbs)
OZ-15-100	14.4	600	4,000	15,000	100,000	2,350
OZ-15-250	14.4	600	10,000	25,000	250,000	2,370
OZ-15-250	14.4	1200	10,000	25,000	250,000	2,470
OZ-23-250	23	600	6,300	12,000	250,000	2,370

CHALMERS

A-C ALLIS-CHALMERS

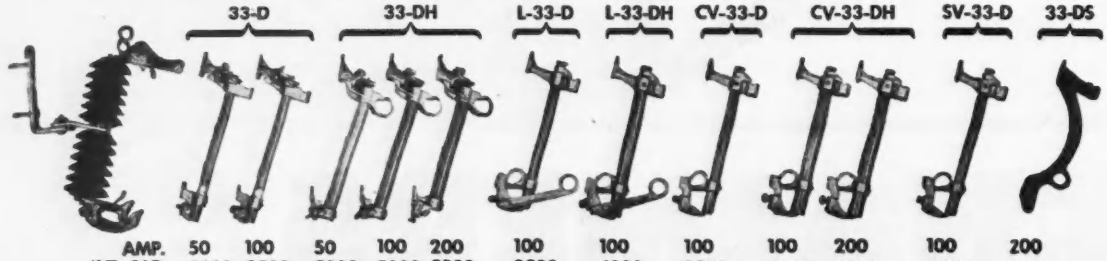
NEW ADDITIONS to an old

Type L-33-D
Load Break Cutout

Illustrated below is a 15 kv Type L-33-D shown at the instant the fuse link is broken within the tube by pulling the lever arm with a hookstick. In this case all gases are vented at the lower end of the tube since gas pressure was insufficient to open the valve at the top.

interchangeability

Southern States cutouts afford maximum versatility to meet changing system requirements. For each standard duty cutout mounting (as illustrated), 11 fuse holders are mechanically interchangeable in each voltage rating.



family of cutouts...

Type CV-33-D
Control Vented Cutout

This 15 kv Type CV-33-D cutout is shown interrupting a moderately heavy fault current. In this instance pressure from the gases generated by the arc of the rupturing link is sufficient to open the valve at the top of the tube allowing gases to escape at both ends of the fuse holder.

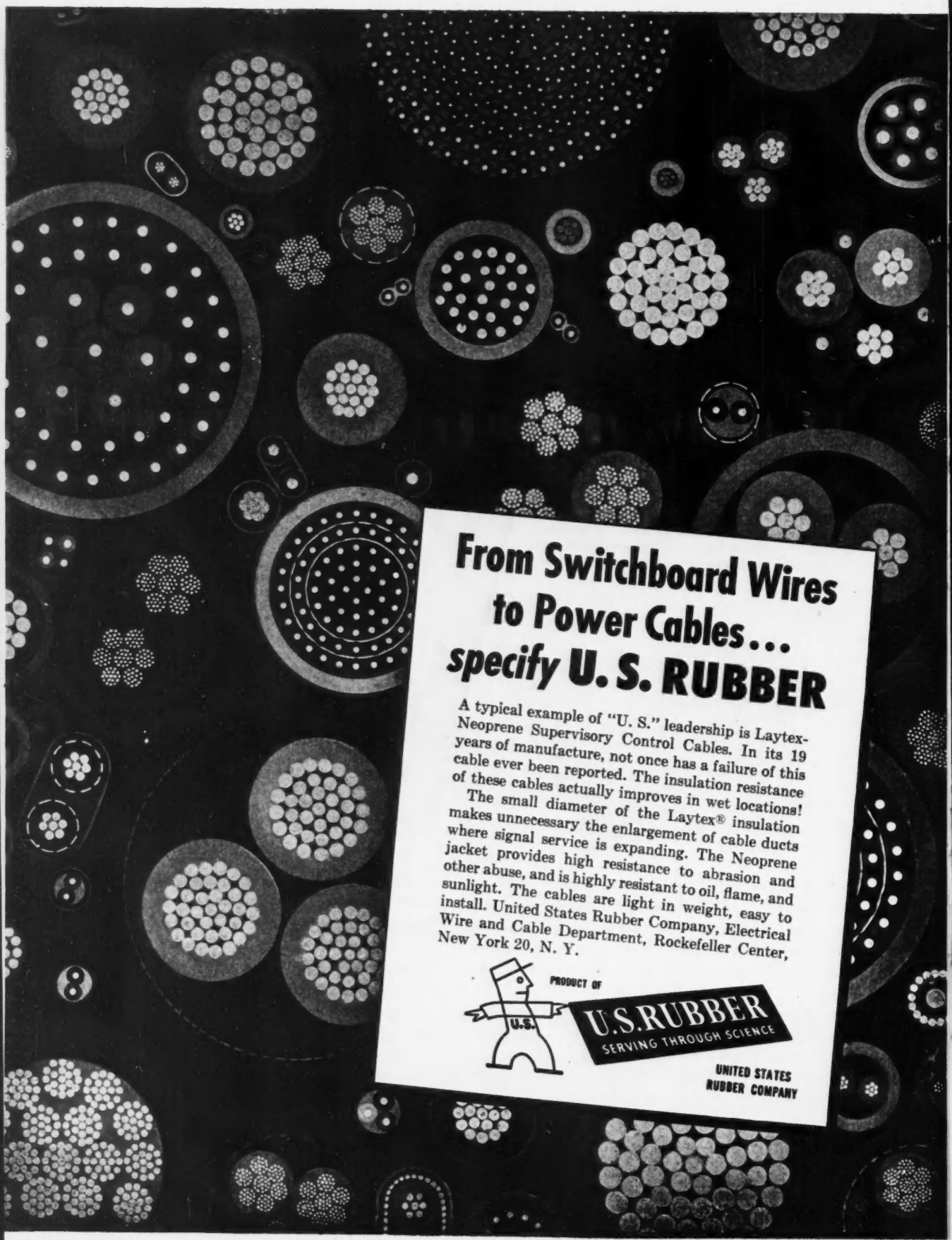
The Type 33 family of cutouts has new additions in the Types L-33-D and CV-33-D. The Type L-33-D affords full manual load break operation up to the continuous rating of the cutout. Both cutouts feature control venting, plus all the advantages of a line that has been tested and proved through the years.

Load break operation in the L-33-D is accomplished by simply pulling a lever arm with any hookstick. The fuse link is ruptured mechanically within the tube causing the fuse to operate in a conventional manner exactly as under moderate fault conditions.

Both cutouts are designed to use universal button head fuse links and yet retain the advantages of double venting. When interrupting low values of current, the gas pressure is small and all the gas vents from the lower end of the tube. Under heavy fault conditions the gas pressure is great enough to operate a valve in the top of the fuse tube, allowing gases to vent freely at both ends of the tube. The result is greater interrupting capacity for a given size tube.

These cutouts are designed so that their fuse holders are fully interchangeable in Type 33-D and older type fuse mountings.

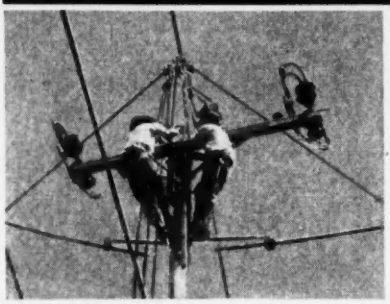
Southern States Equipment Corp.
HAMPTON GEORGIA


From Switchboard Wires to Power Cables... specify U. S. RUBBER
A typical example of "U. S." leadership is Laytex-Neoprene Supervisory Control Cables. In its 19 years of manufacture, not once has a failure of this cable ever been reported. The insulation resistance of these cables actually improves in wet locations!
The small diameter of the Laytex® insulation makes unnecessary the enlargement of cable ducts where signal service is expanding. The Neoprene jacket provides high resistance to abrasion and other abuse, and is highly resistant to oil, flame, and sunlight. The cables are light in weight, easy to install. United States Rubber Company, Electrical Wire and Cable Department, Rockefeller Center, New York 20, N. Y.
U.S.
PRODUCT OF
U.S.RUBBER
SERVING THROUGH SCIENCE
UNITED STATES RUBBER COMPANY

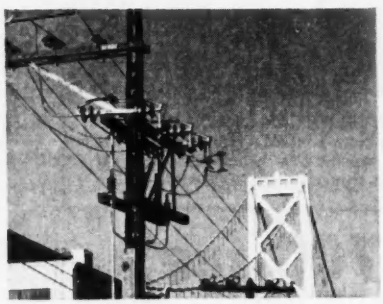
KPF

AIR BREAK SWITCHES

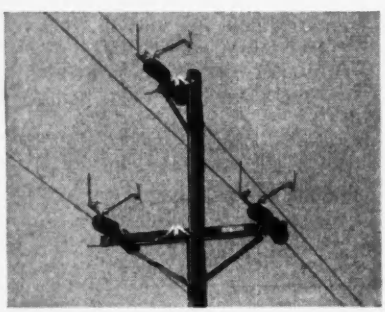
Standard for nearly half a century



Installing KPF Type A-202 switch hot on 12 kv line. KPF phase units are shipped completely assembled, ready for quick installation.

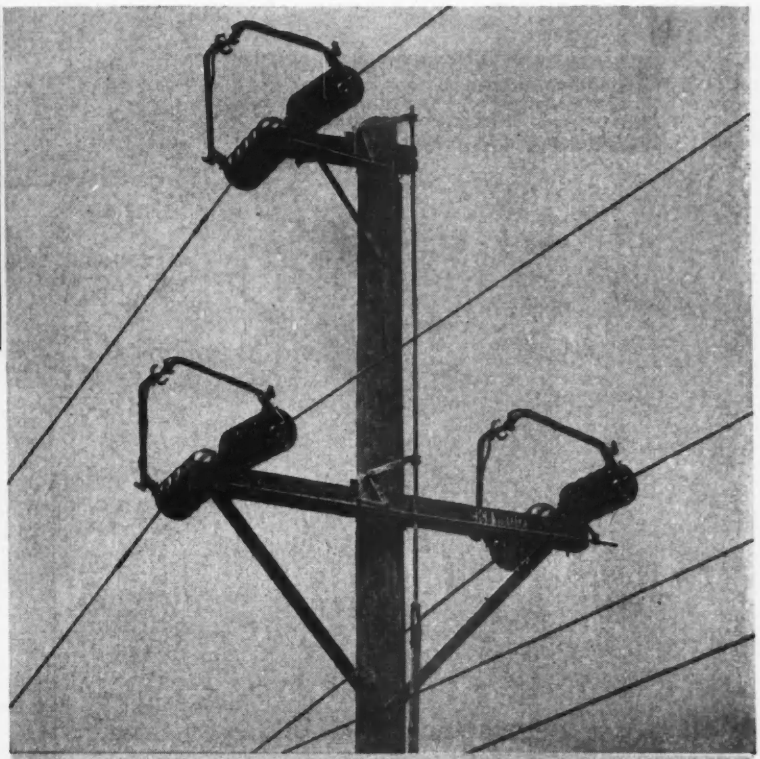


Horizontal-mounted KPF Type UF-2 switch in metropolitan service (P.G.&E., San Francisco). Versatile KPF switches operate equally well with or without line tension.



KPF Type S-205 switches with inexpensive Quick-Break attachment on 60 kv rural transmission line. Switch shown in open position.

2825



Basically different switch design proven in decades of service with leading utilities

Service-proved KPF switches look different because they *are* different.

Their simple, sturdy design insures freedom from mechanical failure or lubrication worries, and virtually eliminates maintenance. Self-aligning silver surfaced blades operate smoothly despite severe ice or crossarm warpage conditions. Installation is fast and economical—switches are bolted directly to crossarms on the ground or in the air. No separate strain insulators or extra crossarms are required; integral insulator stacks readily adjust to line sag.

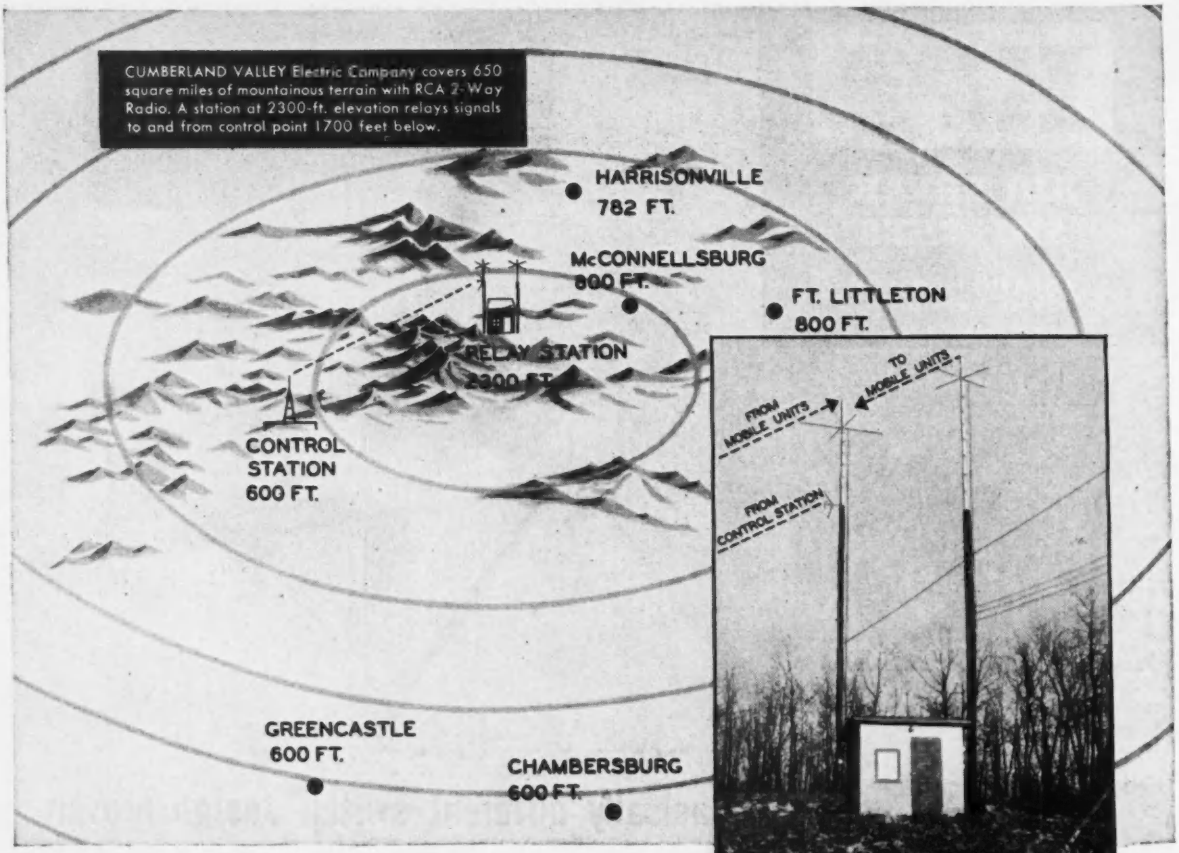
KPF switches have been used for almost 50 years on lines ranging from 7.5 to 110 kv. Tens of thousands are in use today by Pacific Gas & Electric, Southern California Edison, Minnesota Power & Light and other leading power companies throughout the world.

For the world's simplest, surest, lowest cost air break switch, specify KPF—standard for nearly 50 years.

New catalog gives complete specifications, detail drawings, installation information.

KPF ELECTRIC COMPANY

1624 East Alpine Avenue, Dept. E-1, Stockton 5, California



HILLTOP RELAY STATION receives signals from control station on 73.98 mc. and from mobile units on 48.54 mc. Station transmits on 37.58 mc.

RCA 2-Way Radio raises Cumberland Valley 1700 feet

VHF radio relay has recently converted a difficult piece of terrain into ideal radio territory for Cumberland Valley Electric Company, of Mercersburg, Pennsylvania.

Working with RCA communications men, Cumberland Valley engineers virtually lifted the utility's headquarters from its valley site, and placed it on a hilltop seven miles away. From this vantage point the company achieves unusual efficiency, over its 650 square-mile service area.

In addition, the installation permits twenty-four-hour communication between mobile units without requiring a twenty-four-hour dispatcher. Superior car-to-car communication, provided by the hilltop relay, keeps crews in direct contact with each other during dispatcher's off-duty hours.

For engineering assistance on difficult communications problems, contact the RCA Communications Specialist at your local RCA Regional Office. For day-in, day-out dependability, specify RCA 2-Way Radio. For Literature... clip coupon below, and mail it today.

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COMMUNICATIONS EQUIPMENT CAMDEN, N. J.

Radio Corporation of America
Communications Equipment, Dept. 45TE
Building 15-1, Camden, New Jersey

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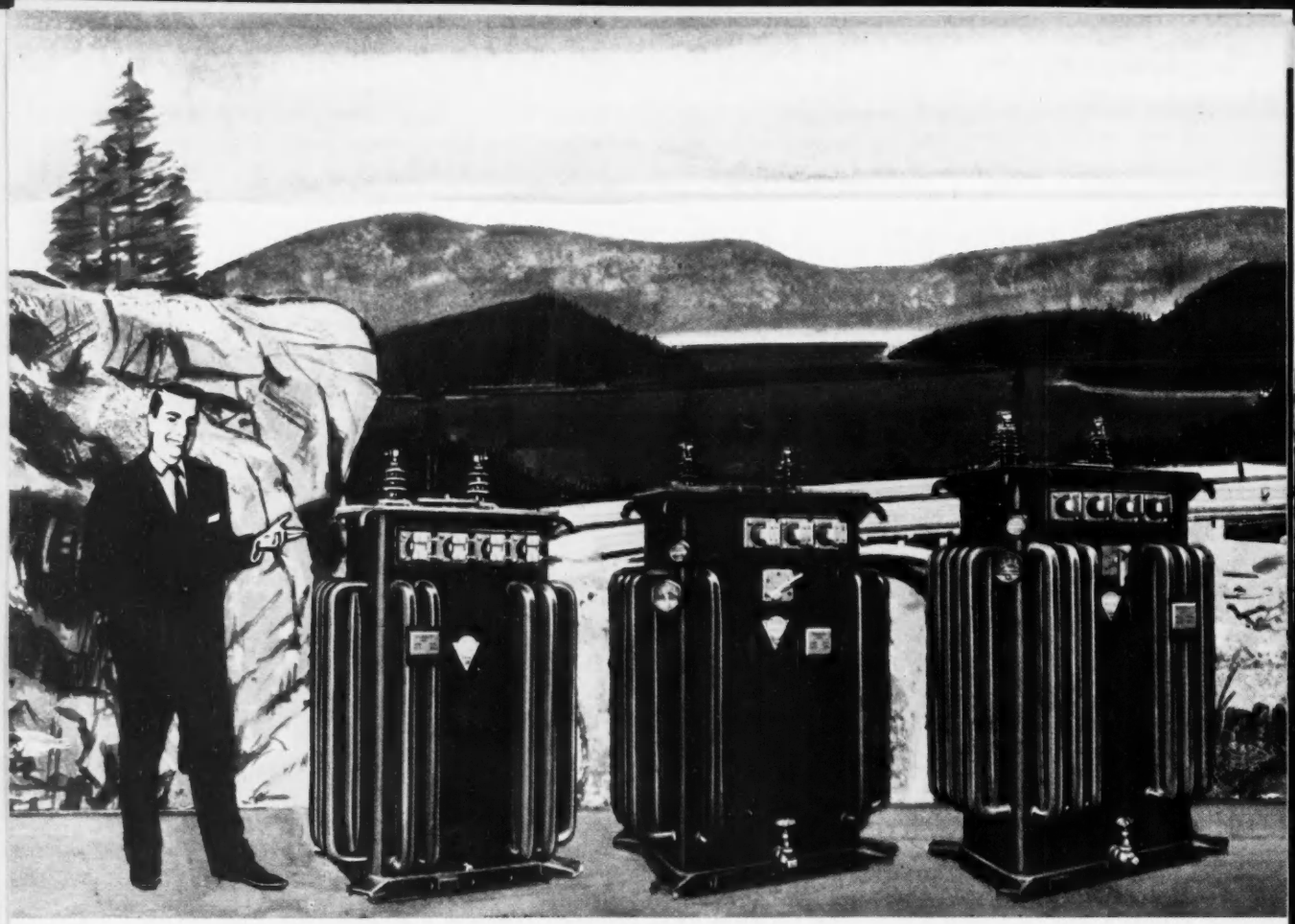
☐ Please have an RCA Communications Specialist call on me.

Name_____ Title_____

Company_____ Address_____

City_____ Zone____ State_____

Compare the Things That Count
L-M's New Large Round-Wound Transformers Are 20% Lighter... Exciting Current Is 70% Lower
New 167 kva • 250 kva • 333 kva • 500 kva
New Fifth Report Standard 167 to 500 kva Round-Wound transformers offer uniformly high impulse strength and high short-circuit strength, improved regulation, lower overall losses, low exciting current, excellent overload capacity.
L-M's new 167 kva Round-Wound transformer is lighter for easier and safer pole mounting.
LINE MATERIAL
Transformers
LM



The four new large Round-Wounds. Left to right, 167 kva, 250 kva, 333 kva, and 500 kva. Units are available in all standard voltage ratings through 14400 volts. The table gives the dimensions and weights of units rated 7200/12470Y to 120/240 volts on the 167 kva size and 240/120 volts in larger ratings.

KVA	Overall Height	Overall Width	Overall Depth	Total Net Weight lbs.
167	66⅞"	40⅞"	25⅞"	2100
250	69⅞"	44"	32"	2850
333	73⅞"	46"	38⅛"	3650
500	79"	54"	43"	4650

L-M's New Large KVA Round-Wound Transformers Are 20% Lighter; Exciting Current Is 70% Lower

By **ALVIN B. COYLE,**
Manager,
Transformer Sales
Line Material Company

To meet the new standards recommended by the EEI-NEMA committee's Fifth Report, a number of design changes have been made in L-M's 167 to 500 kva transformers.

Along with these changes, we have completely redesigned the line in all voltage classes to take full advantage of the inherent qualities of the Round-Wound style of design, an L-M exclusive.

20% Lighter

The result is a line of transformers that offers many distinct advantages to our customers. For example, our new designs average 20% less weight than our old designs.

Cores are of oriented grain cold-rolled silicon steel strip. Taking full advantage of this steel by the Round-Wound design is an important factor in this weight reduction.

Exciting Current 70% Lower

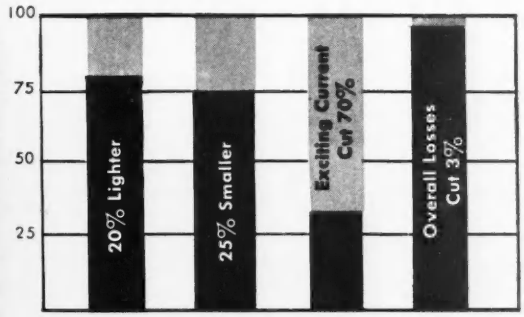
Exciting current has been reduced 70%, a drastic reduction that obviously offers a desirable saving. Other losses have also been reduced. On the average, total losses are down about 3% from those of our older designs, which is a further reduction in losses that were already remarkably low. This reduction in losses has been accomplished coincidentally with reduced size, lower exciting current, and other improvements.

Excellent Regulation

A low value for regulation dictates a low impedance. Conversely, a high impedance contributes to improved short-circuit strength.

The new large kva Round-Wounds are designed to give the best regulation compatible with the other desirable performance characteristics. This is an example of L-M's "Balanced Performance" design.

Compare the Things That Count



Bars show average improvements in new Fifth Report designs over our own previous 167 to 500 kva transformers.

20% Lighter: weight has been reduced on the average of 20%. The 167 kva can now be pole-mounted more safely and easily.

Sizes Reduced Up To 25%: with the new design, size has also been reduced.

Exciting Current Cut 70%, with the new design.

Overall Losses Cut 3%: losses that were already low have been further reduced.

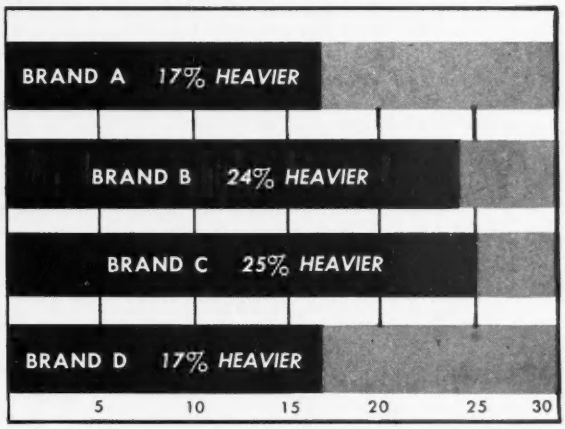


Chart shows how much heavier four other well-known makes of transformers are than the new L-M. Figures are based on the 500 kva, 7200/12470Y—240/120 volts. This is typical of weight comparisons on other ratings and voltage classes.

Uniformly High Impulse Strength

The excellent field record of the smaller sizes of Round-Wound transformers under all service conditions is a tribute to the basic principles of this efficient L-M style of construction. Uniformly high impulse strength and excellent overload capacity are fundamental to the Round-Wound transformer. The new large kva units have been designed to take full advantage of these very important characteristics.

Smaller Sizes

The new Round-Wounds in larger sizes are designed to give the most quality in the smallest and lightest package. The things that count have been given unlimited consideration in design and manufacture.

Let Us Tell You The Whole Story

Ask the L-M Field Engineer for descriptive literature and specifications of the new L-M Round-Wound transformers. Or write Line Material Company, Transformer Division, Zanesville, Ohio (a McGraw Electric Company Division).

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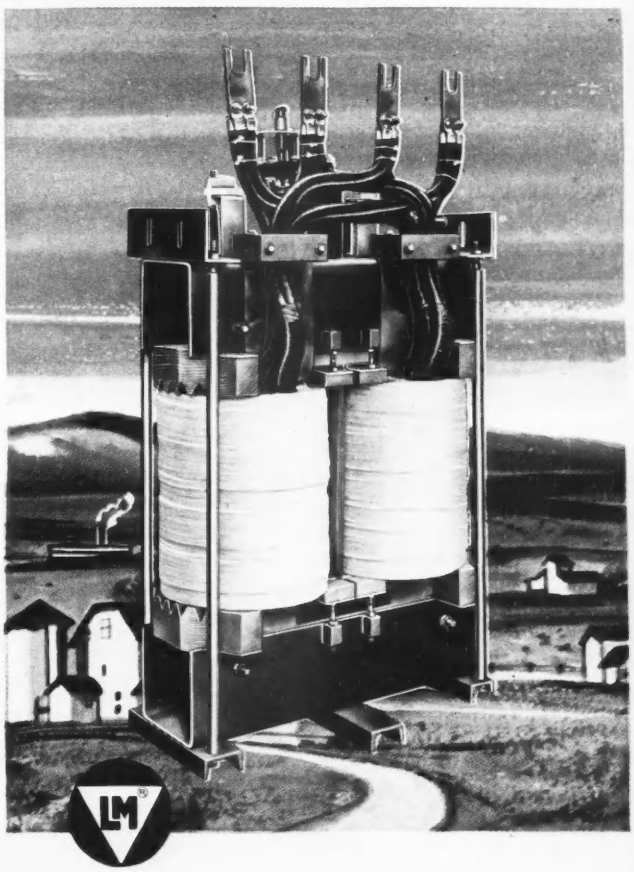
Core-Coil Assembly

Core and coil assembly of the new 500 kva Round Wound. Note the compact, strong construction; the ample surface exposed to cooling oil; the strong frame and heavy blocking for high short-circuit strength.

"Round-Wound" is a Line Material Company trademark



LINE MATERIAL Transformers

You Get Advantages Like These In L-M Round-Wound Transformers

Round-Wound construction consists of round coils, wound directly onto a wound core. The core is wound, then annealed. It is not cut, unwound or otherwise disturbed. L-M is the only manufacturer making a core this way. The result is a magnetic circuit with uniformly low excitation losses. Coils are wound directly onto the completed core by L-M's exclusive process. This construction offers many advantages.

Better Cooling—Higher Short-Time Overload Capacity

The long round coils present large, unobstructed surfaces to the cooling oil. In addition, the cruciform-cross-section core provides natural oil passages between coil and core for additional cooling. That is why, in the Round-Wound transformer, heat is dissipated more rapidly and more uniformly, providing higher overload capacity.

High Impulse Strength

The Round-Wound design has inherently strong insulation, and allows the designer to provide substantially longer creepage distances than is possible in other types of construction. Therefore, the Round-Wound design has uniformly high impulse strength, which is borne out by extensive laboratory tests and field service experience.

High Short-Circuit Strength

Round coils naturally resist radial short-circuit forces without distortion; and the heavy frame and strong blocking prevent axial movement of coils. Thus Round-Wounds have extremely high short-circuit strength.

"Balanced Performance"

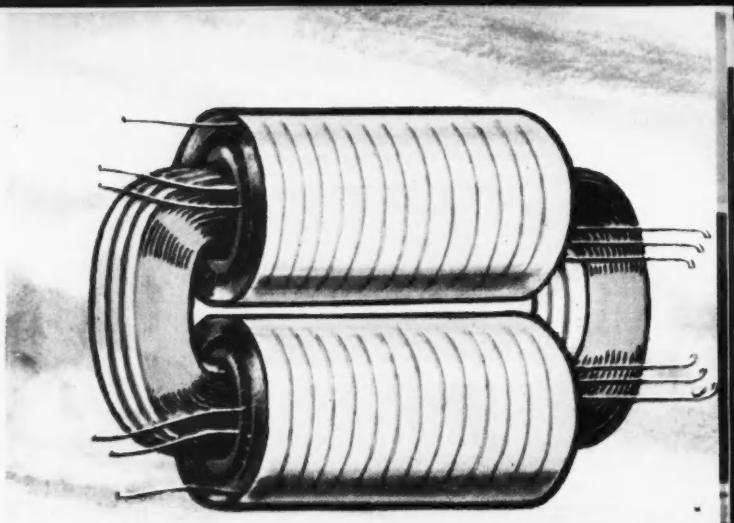
Physical and performance characteristics are well balanced in the Round-Wound transformer. No one characteristic has been emphasized at the expense of another.

Get Complete Information

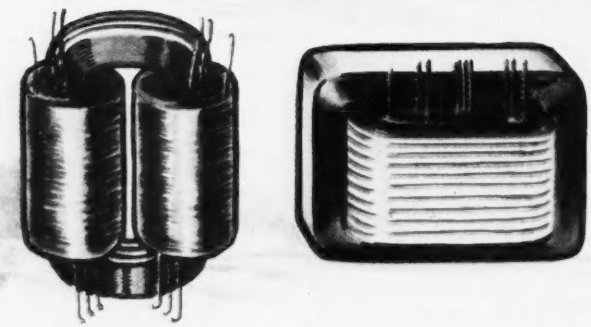
Ask the L-M Field Engineer for complete information on the construction and characteristics of L-M Round-Wound transformers; or write Line Material Company, Transformer Division, Zanesville, Ohio (a McGraw Electric Company Division).

"Round-Wound" is a Line Material Company trademark

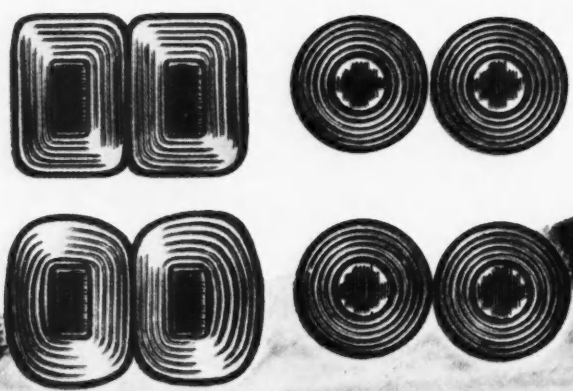
LINE MATERIAL
Transformers



Round coils are wound directly onto the completed core. The core is not disturbed, cut or disassembled after annealing. Coils surround a maximum of the magnetic circuit. They present a relatively large area to cooling oil.



Round-Wounds have high impulse strength, because they provide better insulation and longer creepage paths, as seen by comparing typical Round-Wound with typical shell-type construction.



Short-circuit strength is high. Round coils suffer no radial distortion, as compared with coils of rectangular cross section. Heavy steel frame, strong blocking, and varnish of extremely high bonding strength contribute to prevent axial movement under short-circuit stresses.

Compare { performance value *price*

Easy on the Budget. New R-170 Series. GVW ratings 16,000 to 19,500 lbs. Gasoline or LPG power. Famous Comfo-Vision cab.

NOW—new low prices on light, medium, and light-heavy duty models

Compare performance. Compare the proved performance of Internationals, model for model, with any truck on the road. Prove to yourself that Internationals are today's top truck buy.

Compare value. Compare the extra value in Internationals, detail by detail, with any comparable model. Compare the low operating cost. Compare the low maintenance cost, the long life. Compare the job specialization that's possible with Internationals. You will find that Internationals are *your* best buy.

Compare price. *Every* new International, with its unmatched performance and unmatched value, compares favorably in price with any other truck. Ask about new low prices. See your International Dealer or Branch *today.*

America's Most Complete Truck Line

168 basic models from ½-ton pickups to 90,000 lbs. GVW off-highway models . . . 307 new features in the new R-line . . . 29 engines available with widest practical choice of gasoline, LPG, or diesel power . . . 296 wheelbases . . . wide selection of body types and styles . . . thousands of variations for exact job specialization.

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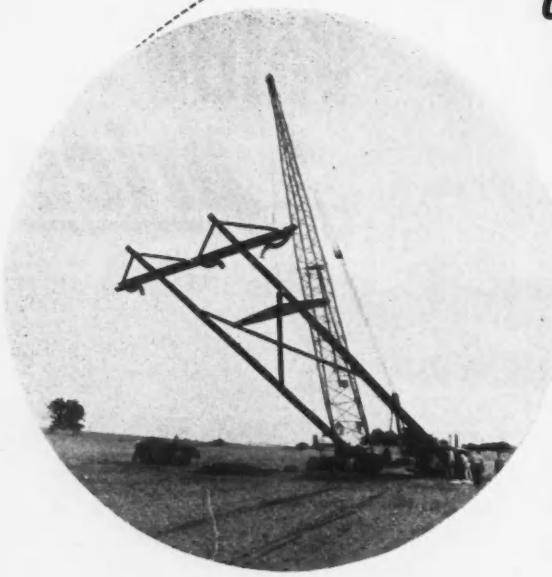
Better roads mean a better America

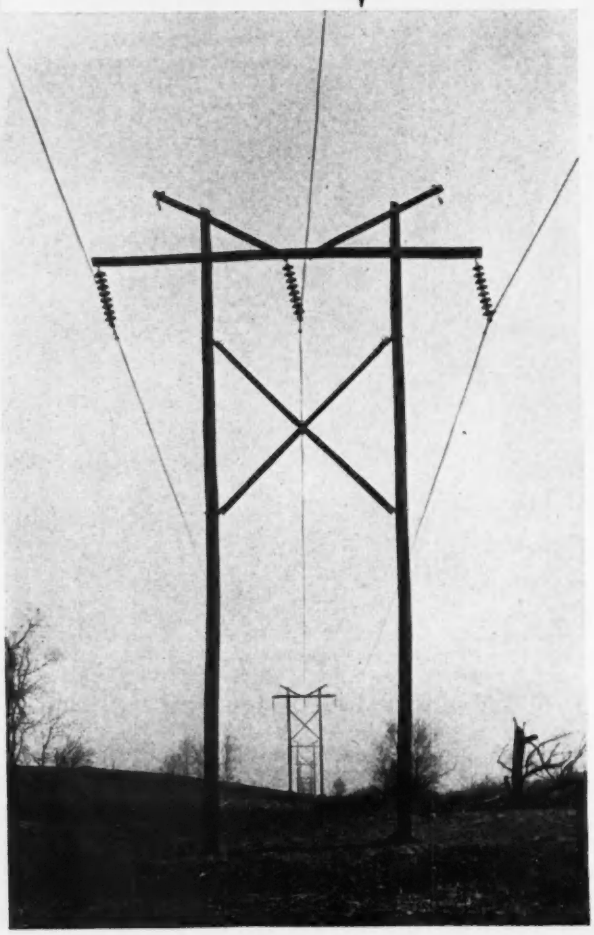
INTERNATIONAL TRUCKS

"Standard of the Highway"

specialists in construction and maintenance

OF TRANSMISSION LINES
DISTRIBUTION SYSTEMS
SUBSTATIONS
for
Electric Utilities & Industry





EXPERIENCE assures dependable results at low costs. Well equipped in executive ability, capable manpower, modern tools and equipment to undertake the most extensive projects. The combined experience of our personnel has many successful years of construction and maintenance work to recommend it.

•

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SERVING THE ELECTRICAL INDUSTRY SINCE 1891

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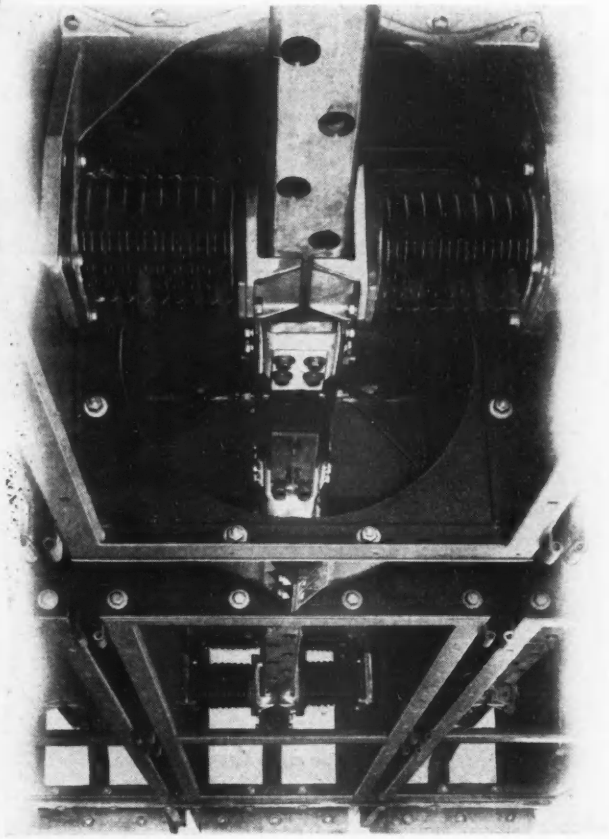
ROLLER SMITH ELPECO

METAL-ENCLOSED BUS



is Pre-assembled

Ease of installation is one of the outstanding features of all ELPECO bus. Each structure is completely assembled at the factory—then shipped to you in convenient-to-handle, easy-to-install sections.

Because each shipping section is a complete factory assembled unit, including hangers, you are assured of a perfect final installation with a minimum expenditure of time, effort and money.

ELPECO bus structures are available in Non-Segregated Phase, Segregated Phase and Isolated Phase types—for indoor and outdoor uses—designed and constructed to conform to N.E.M.A. standards—furnished in all ratings of 600 volts to 34.5 kilovolts and 600 to 7000 amperes.

For full information write for Catalog 5100.

ELPECO DIVISION
ROLLER-SMITH CORPORATION
BETHLEHEM PENNA.

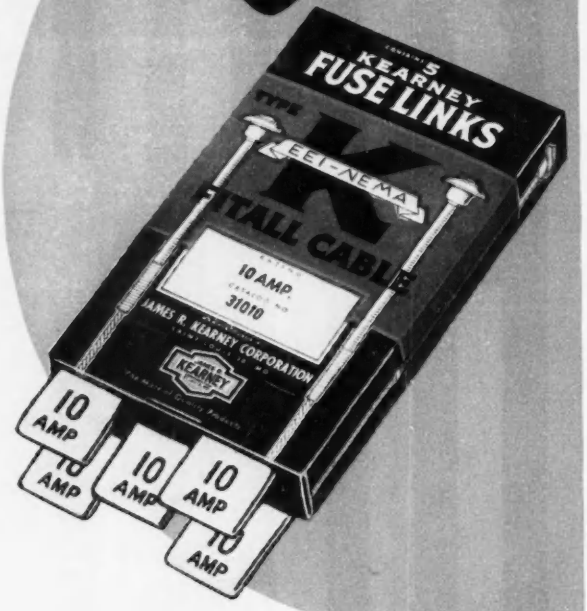
CHOOSE THE FUSE LINK

Standardized

New KEARNEY Type K and T
Made to Meet EEI-NEMA Standards

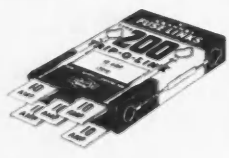
In cooperation with EEI and NEMA KEARNEY has developed K (fast) and T (slow) fuse links to meet industry-wide, time-current standards . . . *in addition* to giving you such exclusive KEARNEY features as:

1. **True mechanical interchangeability because button terminals are threaded**
2. **Greater accuracy and dependability**
3. **Packages are color-coded (silver for Type T—gold for Type K) to assure fool-proof identification and save time on the job**
4. **Easy-to-use, "pull-out" package**

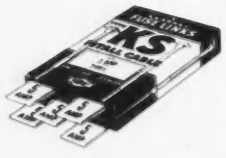


or Specialized

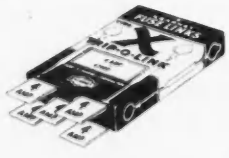
KEARNEY Type 200
Specially made for troublesome circuits that are subject to long-time overloads and surges. Overloads up to 150% can be carried for as long as one hour without damage to fuse link or cutout.



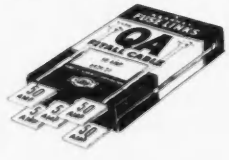
KEARNEY Type KS
Specially designed to protect and still keep outages at a minimum on circuits subject to switching and lightning surges. KS overload capacity is identical with Type 200, but surge capacity is twice as great.



KEARNEY Type X
A specialist at keeping transformers in service during heavy overloads and surges . . . yet clears the fault before damage range is reached. Opens 230% of rated current within five minutes.



KEARNEY Type QA
The QA link is designed to open at a lower percentage of rated current, and therefore will fuse more rapidly than fuse links of the same ampere rating which have been designed to open 230% of rated load within five minutes.



FOR BETTER CONSTRUCTION—FOR SAFER MAINTENANCE

THAT SAVES YOU MOST..

KEARNEY

Gives You a Complete Choice

Whatever your fuse link needs . . . standard or specialized . . . you can be sure of finding exactly the protection you need in the complete KEARNEY line. All KEARNEY links are color-coded to save your crews time and trouble, packaged for easy handling, and made with the accuracy you need for top protection. Time-current curves and charts are available to help you work out your coordination problems.

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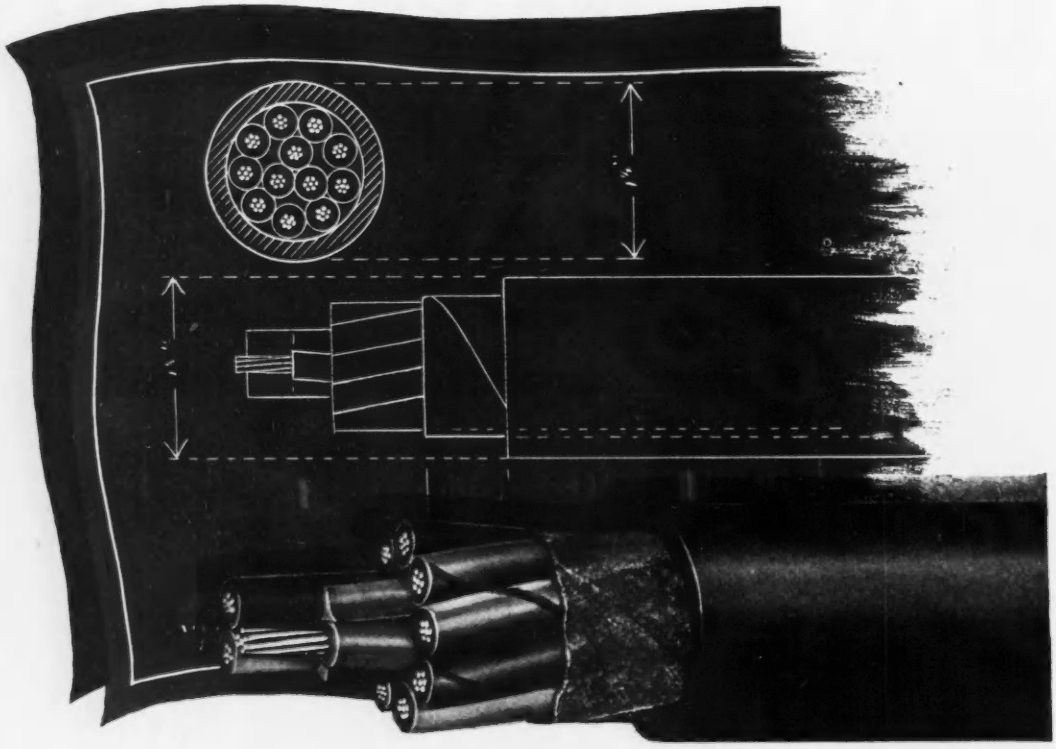


WATERTITE-HAZAPRENE CONTROL CABLE

DESIGN DOESN'T COST... IT PAYS

Good design is just about all that matters in control cables. If you start with good design it will pay off in dependability, long service life and economy.

Watertite-Hazaprene control cables are designed with the following features:

SHEATH: Tire-tough Hazaprene ZBF: neoprene compounded to Hazard's exclusive formula. Offers superior resistance to flame, oil, acid, moisture, sunlight and mechanical damage. Pressure-vulcanized in a continuous metal mold for a smooth, dense surface that resists abrasion and tearing.

INSULATION: Long-lived Watertite, a firm, electrically stable, rubber insulation that resists moisture and heat, prevents deformation.

FILLERS: Rubber, to prevent the wicking-in of moisture and to add firmness to the construction.

CONDUCTORS: Strong and flexible; tin coated to resist corrosion.

There's a Watertite-Hazaprene cable for every control circuit requirement. See your Hazard representative or write for complete information. Hazard Insulated Wire Works, Division of The Okonite Company, Wilkes-Barre, Pennsylvania.

HAZARD insulated cables

1650

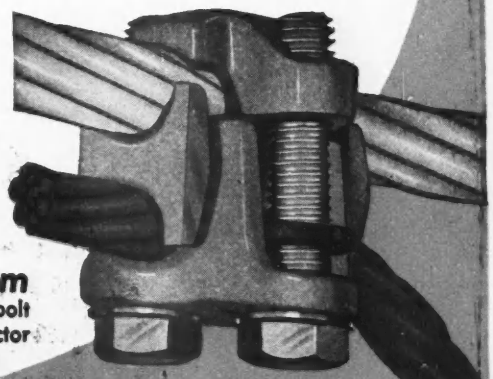
Better Performance
AT LOWER COST!

BLACKBURN
Hi-Strength
TWO-BOLT CLAMPS

Ideal for taps and connections of stranded wire and cable from 1/0 to 1,000,000 CM. Has exceptional clamping ability, and produces a very tight, low-resistance connection. Also excellent as a dead ending clamp. Made completely of high strength materials to give you lasting dependability.

Also furnished with contoured spacer washer to hold the cables in their original round shape and protect the individual strands of the cable.

WITH SPACER WASHER



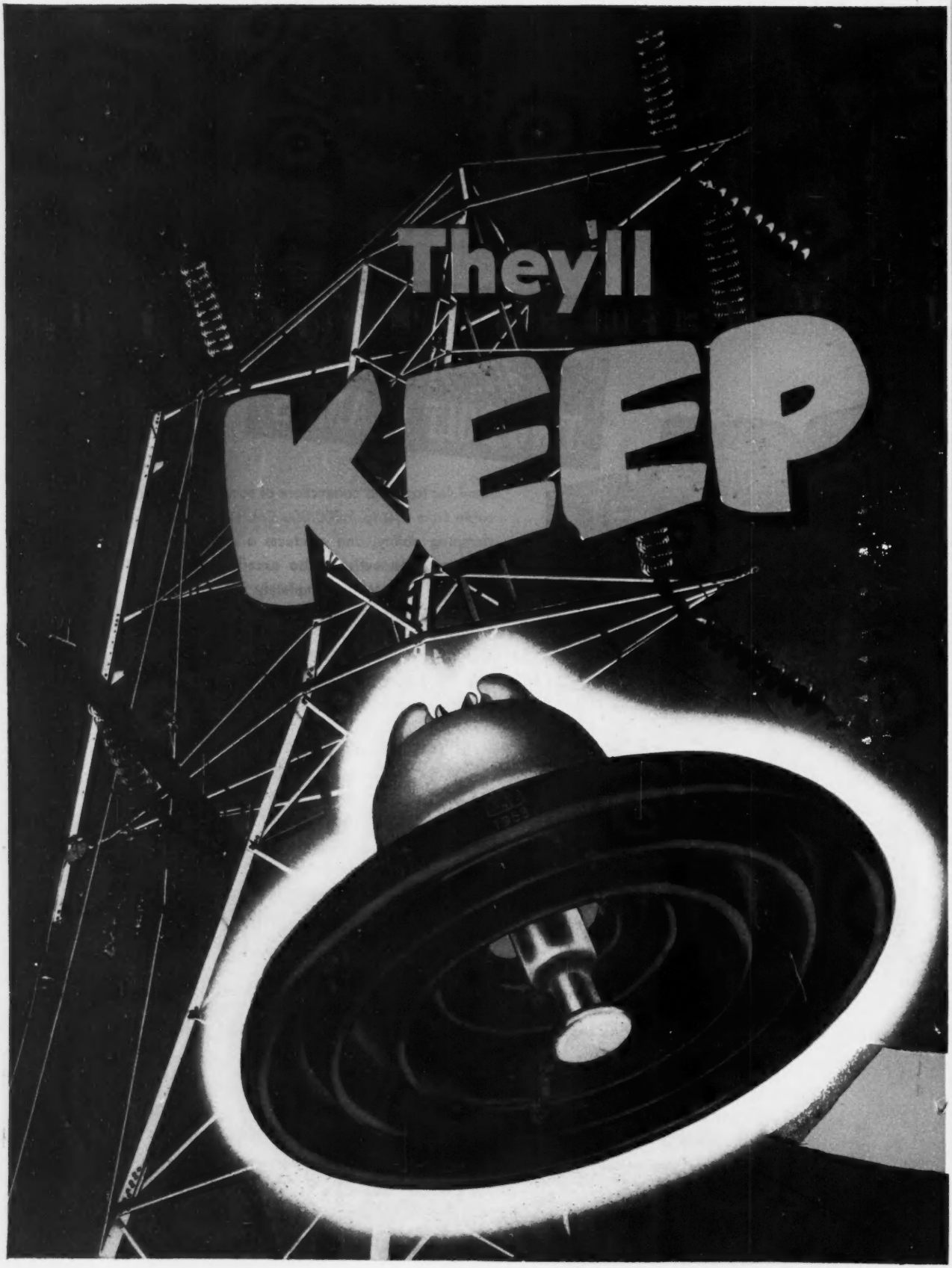
PLATED—*for Use with Aluminum*

Tin plated to minimize danger of electrolysis, the two-bolt clamp with thick spacer washer makes an ideal connector for aluminum. May be used for aluminum to aluminum or aluminum to copper.

Prompt Deliveries—Order Now—From Your Wholesaler

JASPER BLACKBURN CORPORATION

35 MADISON ST. ST. LOUIS 6, MO. CENTRAL 3007


They'll
KEEP

Pennsylvania Electric Compa...
Florida Power Corp.
Puerto Rico Water Resources Authority
Metropolitan Edison Company
New York State Electric & Gas Co.
Iowa Power & Light Company
Eastern Kansas Utilities
Philadelphia Electric Company
Cincinnati Gas & Electric Co.
Central Illinois Elec. & Gas Co.
Kansas Gas & Electric Co.
Pennsylvania Power & Light Co.
Staten Island Edison Corp.
Minnesota Power & Light Co.
Long Island Lighting Co.
Wisconsin Public Service Corp.
Georgia Power & Light Company
Hawaiian Electric Company
Montana-Dakota Utilities
Louisiana Power & Light Co.
Virginia Electric & Power Co.
Idaho Power Co.
Ohio Edison Co.
Green Mountain Power Corp.
Gulf Public Service Co.
Western Light & Telephone Co., Inc.
Lake Superior District Power Co.
Southern Indiana Gas & Electric Co.

'EM UP for you, too!

Bangor Hydro Electric
Houston Lighting & Power Company
Manilla Electric Company
Louisville Gas & Electric Co.
South Carolina Electric & Gas Co.
Memphis Light, Gas & Water Div.
Tucson Gas, Electric Light & Power Co.
Southern Utah Power Company
Oklahoma Gas & Electric Company
Delaware Power & Light Company
Missouri Power & Light Company
Potomac Electric Power Company
Northwestern Public Service Co.
Stone & Webster. Northern States Power Compa
Public Service Electric & Gas Co.
White Mountain Power Company
Iowa Electric Light & Power Co.
Central Ohio Light & Power Co.
Missouri Public Service Corp.
Frontier Power Co. Kentucky Utilities Company
Southwestern Public Service Co.
Atlantic City Electric Company
Toledo Edison Company Montana Power Co.
Appalachian Electric Power Co.
Arkansas Power & Light Company
Iowa Southern Utilities Company
Carolina Power & Light Compa
Monongahela Power Compa
Pennsylvania Power Compa
Florida Power & Light Com
Pennsylvania Electric Company
Gulf States Utilities Company
Detroit Edison Compa...

Keep 'em up and you'll keep your up-keep down.
What's an insulator cost?

Initially a few pennies per year. What does it cost to replace an insulator? Look at your own cost records. It's evident it isn't the initial price that determines the final cost.

Leading utility service records prove it's the QUALITY and STAMINA built into each PORCELAIN PRODUCTS insulator that guarantees low final cost through years of trouble-free service. You too can "*keep-'em-up*" and enjoy these low costs by specifying Porcelain Products insulators when planning your transmission lines.

Want proof? Our representative will be glad to call and explain what our quality controls mean to you in terms of final cost.

PP INC.

Porcelain Products, Inc.

PARKERSBURG, WEST VIRGINIA

NEW UTILITY STATIONS C-E EQUIPPED

Includes stations placed in operation since the war (in white) and those under construction or being engineered.

TIDD • JENNISON
CECIL LYNCH • HAVANA
MEREDOSIA • PERMIAN BASIN
O. H. HUTCHINGS • REX BROWN
HICKLING • B. C. COBB
RUSSELL • SEWAREN
POSSUM POINT • CUTLER
PORT JEFFERSON • WHITE RIVER
POTOMAC RIVER • GADSDEN
W. SPRINGFIELD • WOOD RIVER
DAN RIVER • LAKE CATHERINE
HARRY NEWMAN • JIM HILL
HUTCHISON • YATES
DUNKIRK • TITUS • LEE
CONTRA COSTA • HAWTHORN
NINEMILE POINT • EDGE MOOR
PALATKA • JOHNSONVILLE
DANSKAMMER • BECKJORD
HIGHGROVE • PLANT X
BLACK DOG • ALBANY
JOPPA • MERAMEC
PORTSMOUTH • LAKE CREEK

ETIWANDA

AURORA
HENNEPIN
EASTLAKE
OAK CREEK
MULLERGREN
URQUHART
MILLIKEN
SAGUARO
SUWANNEE RIVER
SANDOW
NELSON
KINGSTON
WILMINGTON
BARRY
JOHN SEVIER
VERMILION
GALLATIN
ISLAND PARK
CARBON

NEW

Etiwanda Steam Station, second postwar steam station of the Southern California Edison Company, went into service recently when the first of two units which comprise the first section of the station was placed on the line.

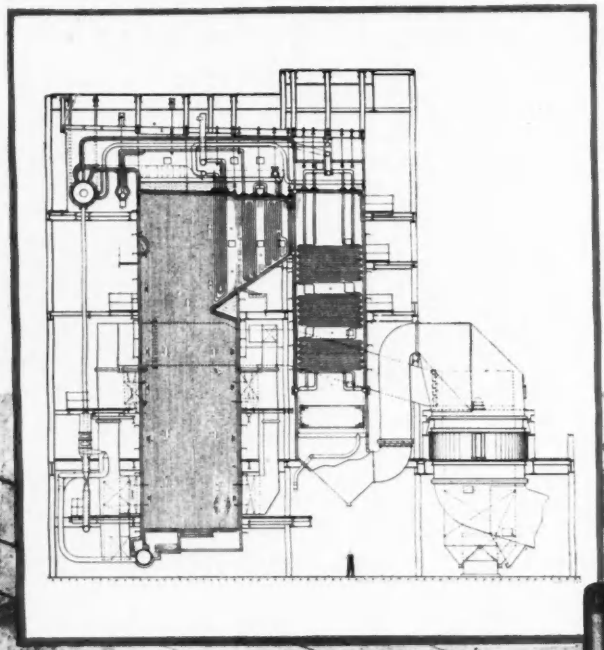
Located about 50 miles east of Los Angeles in the rapidly growing Fontana industrial section, this attractive, ultra-modern station is strategically situated to serve the needs of its own area as well as the requirements of the greater Southern California Edison system.

The station was designed and constructed by Stone & Webster Engineering Corporation in close cooperation with the engineering and operating staff of the Southern California Edison Company. It is an excellent example of the modern "outdoor" design, combining fine appearance, simplicity and ruggedness without sacrifice of efficiency, reliability or economic considerations.

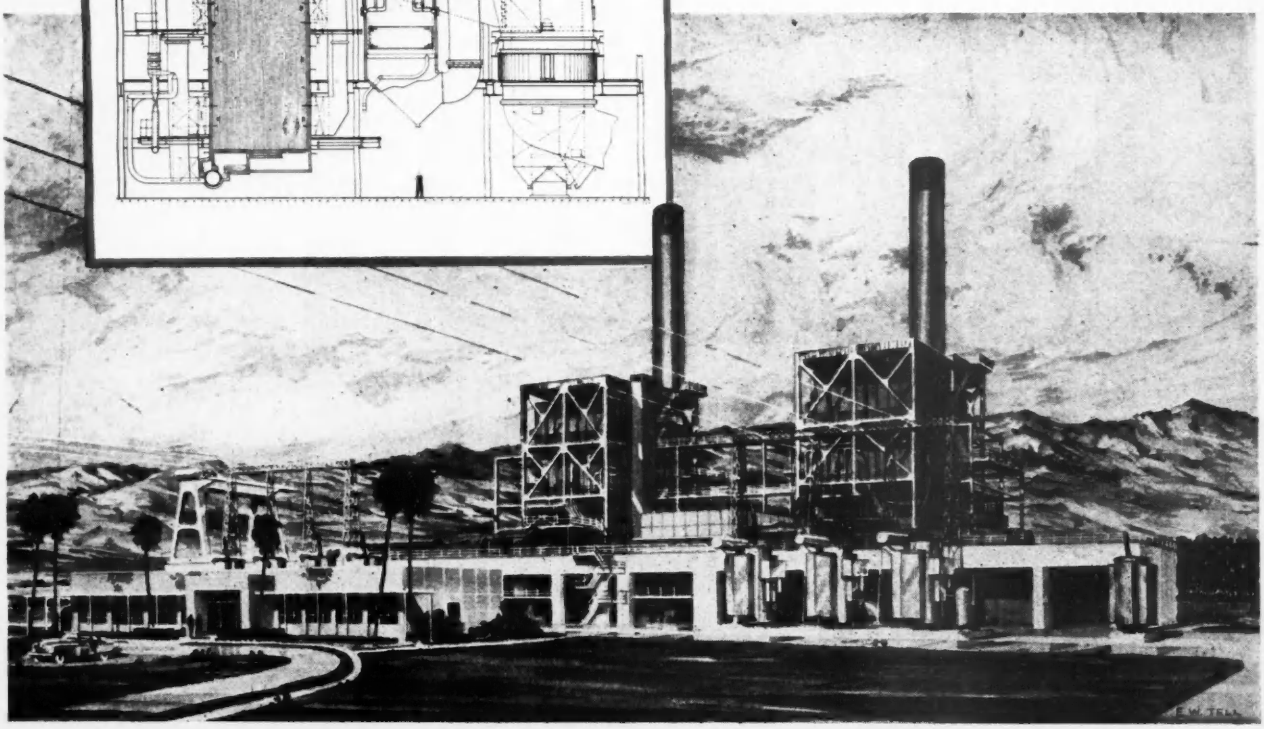
The initial installation comprises two 125,000 kw turbine generators of the reheat type, each served by a C-E Controlled Circulation Boiler, a cross-sectional elevation and brief description of which appears on the opposite page.

COMBUSTION
ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT

Etiwanda Steam Station goes into service



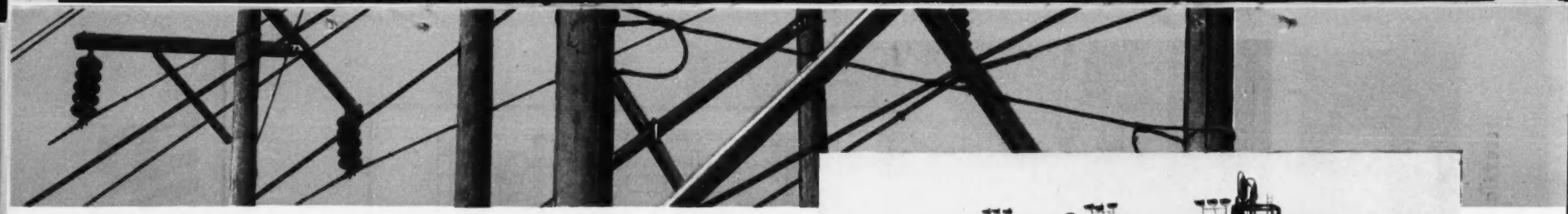
The C-E Unit, shown at the left, is now in service at the Etiwanda Steam Station. A duplicate unit is presently under construction. The units are of the controlled-circulation, radiant, reheat type, with a reheater section located between the primary and secondary superheater surfaces. An economizer section is located below the rear superheater section and regenerative type air heaters follow the economizer surface. Oil or natural gas firing is employed using tilting, tangential burners. The design provides for future conversion to pulverized coal if desired. Each unit serves a 125,000 kw turbine generator operating at a throttle pressure of 1800 psi and a temperature of 1000 F, reheated to 1000 F.



B-687

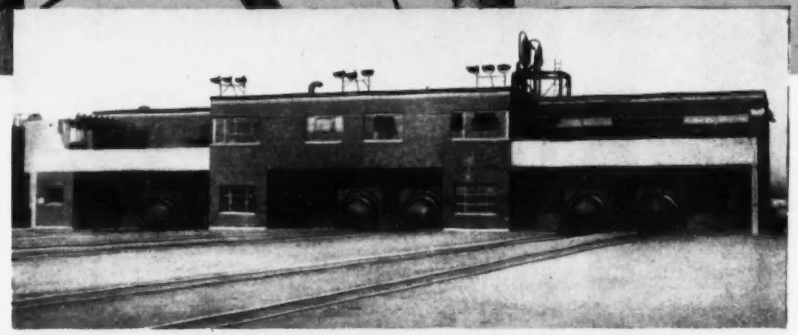
ENGINEERING, Inc.

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.



Fabrication of modern wood transmission structures requires the coordinated productive ability of four major industries: Galvanized pole line hardware ● wood poles and crossarms ● wood preservation by pressure treatment ● electrical porcelain and fittings.

All four industries are integrated within the Joslyn organization. Consequently, Joslyn holds a unique position as a supplier of wood transmission structures: We are proud to be the only manufacturer serving the electrical utility industry who can supply *with his own facilities* complete wood transmission line structures.



Joslyn pressure treating plant—Franklin Park, Illinois (Chicago).

Proper treatment of wood components in any transmission line is of vital importance. The extended service life obtained with *Joslyn incised pressure-treated* wood members not only insures against mechanical failure, but also coordinates life expectancy of the wood with other line components.

As prime producers of wood poles and crossarms, we are in a position to provide our customers with the best fir lumber available, specifically graded to fit the ultimate use.

Pinco electrical porcelain and hardware fittings are a recognized standard in the industry.

Combined with these comprehensive production facilities is a fund of transmission design engineering experience acquired over the past 20 years.

May we have the opportunity of quoting on your future requirements?

Joslyn transmission line hardware is produced in modern plants utilizing the latest type of equipment and production techniques.

Joslyn pole line hardware plant—Chicago, Illinois.

8-53

JOSLYN MFG. AND SUPPLY CO., 20 NORTH WACKER DRIVE, CHICAGO, ILL.

Complete Wood Transmission
Structures by JOSLYN

80 years ~~old~~ young

Age in itself means very little. But age accompanied by historic achievements and age that is continuing to produce the finest products of their type is something of which we are proud.

1873

Founded in 1873, The R. Thomas and Sons Company very early became closely allied to the electrical industry.

1885

In 1885, the first "Thomas Quality" insulator was produced, the first shipment going to the U.S. Electric Lighting Co., Chicago.

1893

In 1893, all of the porcelains used in the lighting arrangement for the World's Fair at Chicago, installed by Westinghouse, were Thomas.

1896

In 1896, Thomas perfected the first multi-part, high-voltage, pin-type insulator. It was known as the "Boch" Glaze-Filled Insulator, later to be patented under No. 600,475. It represented the initial step toward making possible the transmission of electrical energy at higher voltages.

1907

In 1907, Thomas designed and made the first cap-and-pin suspension insulator. Units installed that year are still giving trouble-proof service after 46 years of continuous operation.

1917

In 1917, we introduced the Thomas link-type Hewlett suspension insulators. Insulator failure being virtually unknown with this design, it is easy to understand why hundreds of thousands are still giving satisfactory service today.

1938

In 1938, Thomas engineers pioneered and were first to develop the under-glaze metallic oxide coating that guarantees the "noise-free" operation of the patented Thomas "Q-T" Insulators. (Patent No. 2154387)

These are among the many Thomas "Firsts" and contributions which have helped the Electrical Industry reach its present position.

TODAY, in our 80th year, we are ready with improved facilities and increased capacity to meet the most exacting needs of the Industry. After all is said, it's still quality that counts plus proper designing, precision manufacturing . . . and PROOF OF PERFORMANCE. Why gamble?

The R. Thomas and Sons Co.

1873 THOMAS INSULATORS our 80th year RELIABILITY 1953

LISBON, OHIO

NEW YORK CHICAGO

Sales Representatives: **C. G. Anderson,** *Chicago* • **E. B. Anderson Co.,** *Detroit* • **Conrad R. Bangh,** *Omaha* • **Ken H. Best,** *Seattle* **R. E. Cunningham & Son,** *Los Angeles* • **W. H. Eddy Electric Products, Inc.,** *Phoenix* • **Engineer Sales Co.,** *St. Petersburg* • **Electrical Distributors Co.,** *Philadelphia* • **Hamilton Associates,** *Denver* • **Geo. E. Honn Co.,** *San Francisco* • **Hugo Sales Co.,** *Minneapolis* • **John G. Pettijohn Co.,** *Knoxville* • **H. E. Ransford Co.,** *Pittsburgh* • **J. F. Schaefer & Co.,** *Kansas City* • **R. J. Sullivan Co.,** *Boston* • **Tafel Electric & Supply Co.,** *Louisville* • **Walter E. Thompson Co.,** *Birmingham* • **Triangle Electric Supply Co.,** *El Paso* • **United Electric Supply Co.,** *Salt Lake City* **Williamson Sales Co.,** *Shreveport, Amarillo, Corpus Christi, Dallas, Houston, New Orleans, Pine Bluff* • *Representatives in other principal cities*

... and now IN 1953, another THOMAS FIRST...

... A new petticoat design in the 10-inch suspension insulator that positively prevents chipping or breaking of inner petticoats. This protection is assured by eliminating the destructive bumping of caps or clamp fittings against the petticoats, yet complete interchangeability with all current designs is guaranteed as required by NEMA Standards. Only this new Thomas design can guarantee that it is virtually impossible to damage inner petticoats by rough handling during assembly or disassembly in the field.

● Naturally, we are excited. We believe our new petticoat design to be the answer to the insulator breakage problem, during construction, which has plagued the Industry for years. This design accomplishes positive elimination of insulator breakage during construction due to rough handling in coupling and uncoupling insulator units and in installing hardware fittings to the insulator strings.

Of course, the greatest benefit of this new design will be realized with the close-spaced, five-inch spaced units, but for all insulator spacings, our new design assures more ruggedness with resulting longer life . . . and at no additional cost to you!

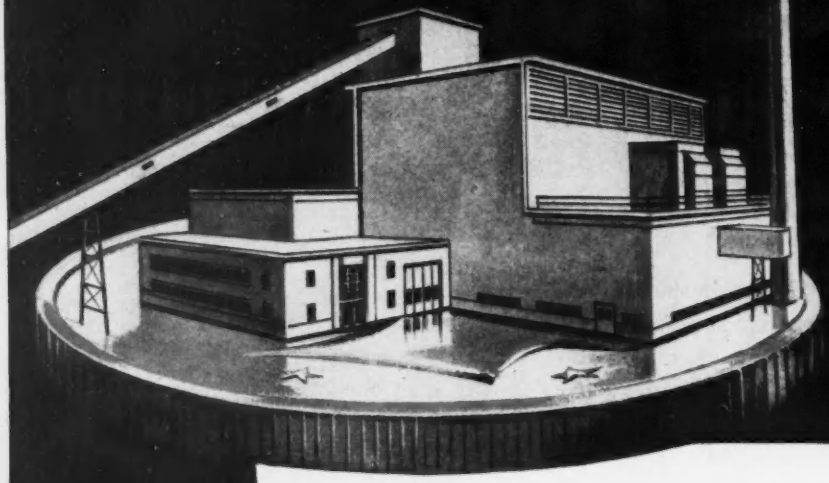
The foregoing are bold statements. However, our most severe tests prove them and they are too important for you not to verify.

We suggest that you order TODAY, a standard crate of 6—No. 21239 THOMAS 1953-DESIGN SUSPENSION INSULATORS. Test them thoroughly . . . and compare with other five-inch spaced designs.

Specify **THOMAS INSULATORS—THE BEST BY LINE TEST**

The R. Thomas and Sons Company is a manufacturer and designer of all types of porcelain insulators . . . pin-type, switch, suspension, spools, guy-strain, bushings and special high-voltage porcelain. In addition, Thomas supplies associated line hardware, clamps, fittings, and so on.

The Proper Power Plant for You Requires MORE THAN GOOD DESIGN



Today more than ever prudence requires that a sizable fixed investment such as a power facility be carefully integrated with the corporation's financial structure and founded on an accurate anticipation of the company's load, possible sources of power and future economic trends.

Such forehandedness is an integral part of Pioneer's power plant design work, for Pioneer is not only a consulting and design engineering group but an organization of financial and economic specialists as well, and the two points of view guide and temper one another.

Our past and current power plant work recommends that you bring Pioneer into the early discussion of your power needs.

Does Your Power Plant Leak Profits?

Industrial plant owners as well as utilities can use our operating consulting service profitably to discover ways of improving equipment performance and reducing operating costs.

Are you using the most economical fuel in the most economical way?

Are you using labor to the best advantage?

Are you obtaining maximum performance from the equipment you have installed?

Are there methods of improving your operation by adding supplementary equipment which will more than pay its way?

Our consulting service is based on over fifty years of both design and operating experience. You may be sure, however, that our suggestions will balance between the ideal and the practical, for Pioneer's management viewpoint always balances Pioneer's engineering — an investment safeguard for you.

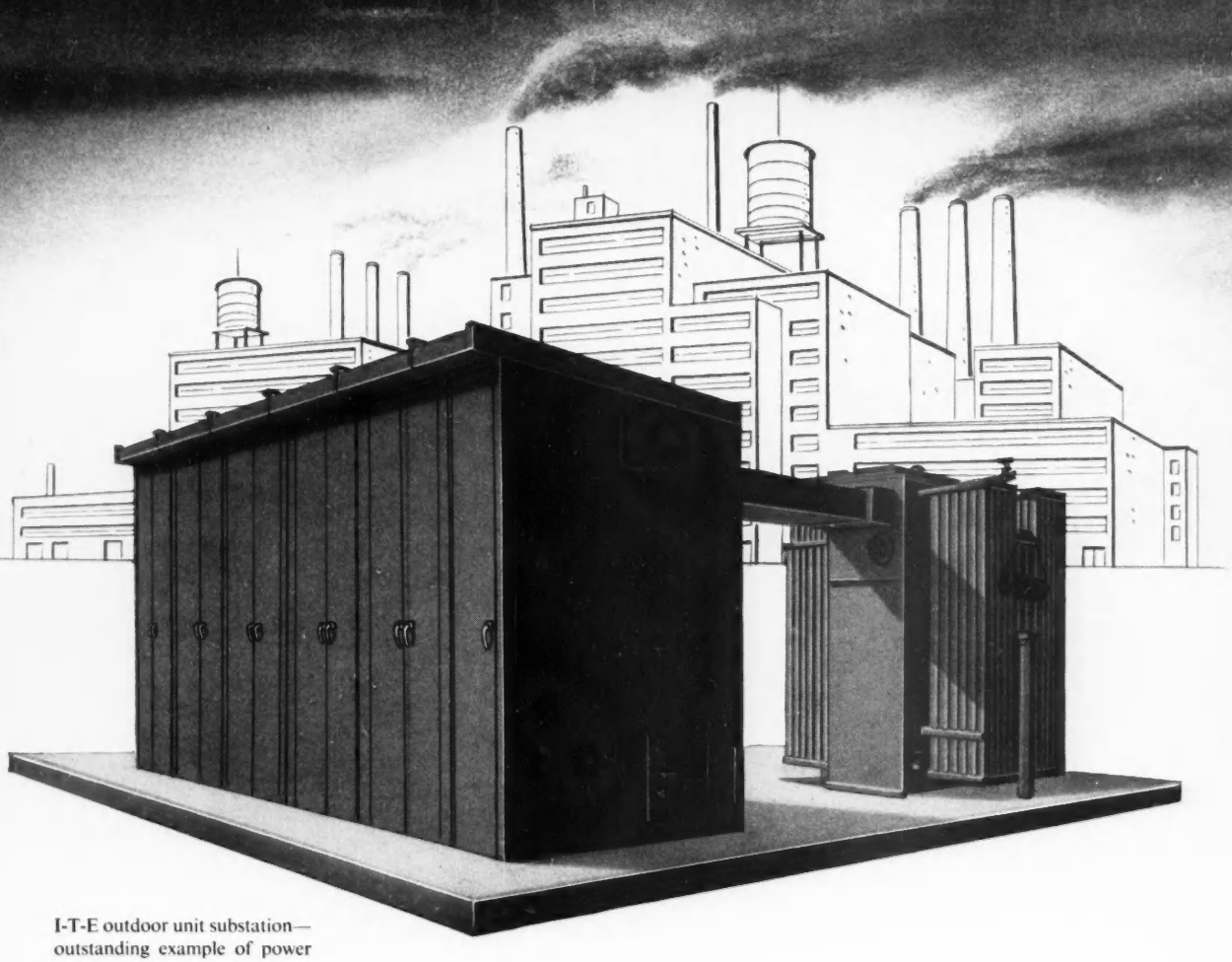
Pioneer Service & Engineering Co.

231 South La Salle Street · Chicago 4, Illinois

PIONEER PS&E 51 YEARS

Planned Power Distribution

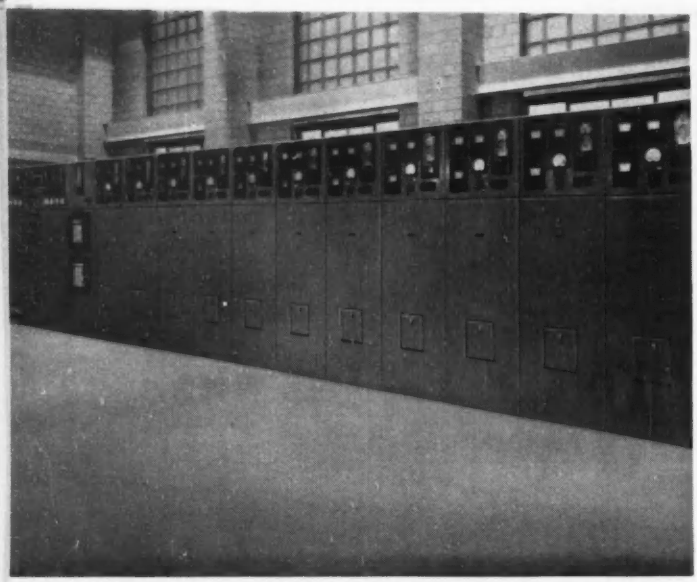
—first step toward increased plant efficiency



I-T-E outdoor unit substation—outstanding example of power equipment planned for efficiency. This substation, a durable, weatherproof unit of transformer and switchgear, can be located close to load center—yet out-of-doors, where it will not take up premium production space inside the plant.

Power is fundamental. The most modern plant, the latest-type production lines can be only as efficient as the electrical distribution system that feeds them.

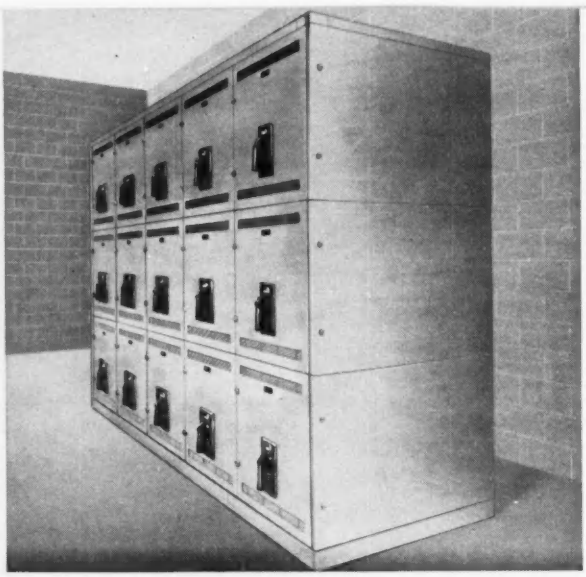
Plan ahead now, and avoid "patchwork" later. An I-T-E application engineer will gladly advise you how to get more efficiency from your power devices, how to lower distribution costs, and get positive electrical protection for your plant.



I-T-E METAL-CLAD SWITCHGEAR

4160 volts — 600, 1200, 2000 amperes
50,000, 150,000, 250,000 KVA interrupting

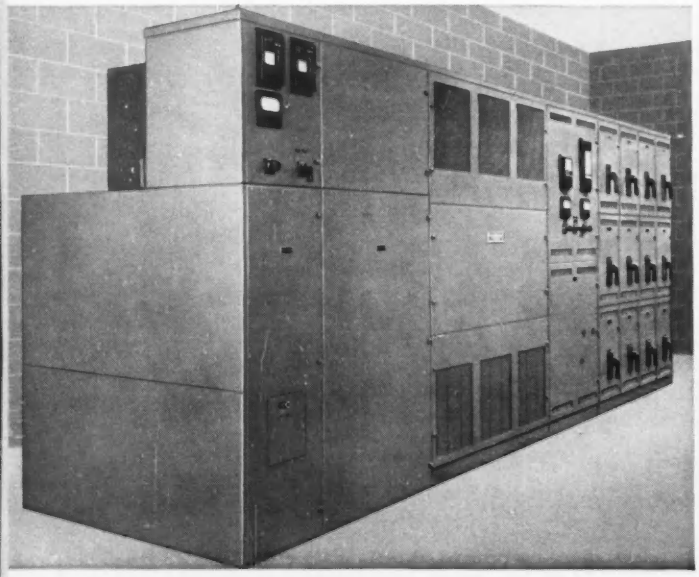
For protection of main incoming lines and feeders. Modern horizontal drawout construction guarantees savings in inspection and maintenance.



600-VOLT DISTRIBUTION SWITCHGEAR

600 volts — 6,000 amperes and below
15,000 to 100,000 amperes interrupting

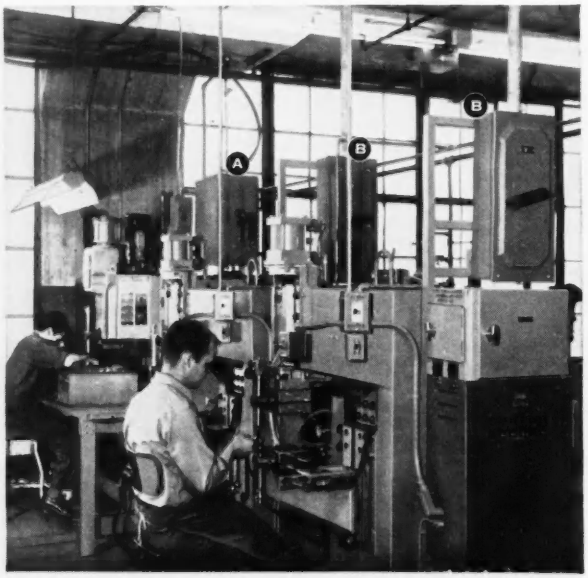
For protection of low-voltage incoming lines and feeders.



UNIT SUBSTATIONS

300 KVA and above—Primary voltage 480 and above

Coordinated Metal-clad and 600-volt switchgear, plus transformer. Substations reduce distribution losses by stepping down voltage near point of utilization.



INDIVIDUALLY-ENCLOSED CIRCUIT BREAKERS

120-600 volts 10-6,000 amperes
5,000-100,000 amperes interrupting

A complete line of large air **(A)**, and molded case **(B)** circuit breakers for protection of single circuits to almost any type of plant equipment.

From power line to production line

. . . I-T-E BOOSTS PLANT EFFICIENCY

From the main plant switchboard to the smallest circuit breaker, I-T-E equipment boosts plant efficiency. Equipment is designed to facilitate efficient power distribution, to guard against overloads and short circuits, and to allow for quick restoration of service in the event of sudden power interruption.

Your plant structure and costly capital equipment are fully protected against electrical hazards at all times. Loads are fed and maintained at proper, efficient voltage. Production lines are kept on the go.

In line with latest thinking, equipment is compact, self-contained—can be located either *indoors* or *outdoors*, according to requirements. Rugged, durable enclosures are available to satisfy every plant need.

Modern design complements modern engineering. Standardized units facilitate expansion. Circuit breakers are easy to get at; maintenance is simple. Breakers can be quickly adjusted to compensate for load changes.

And throughout—safety is the keynote

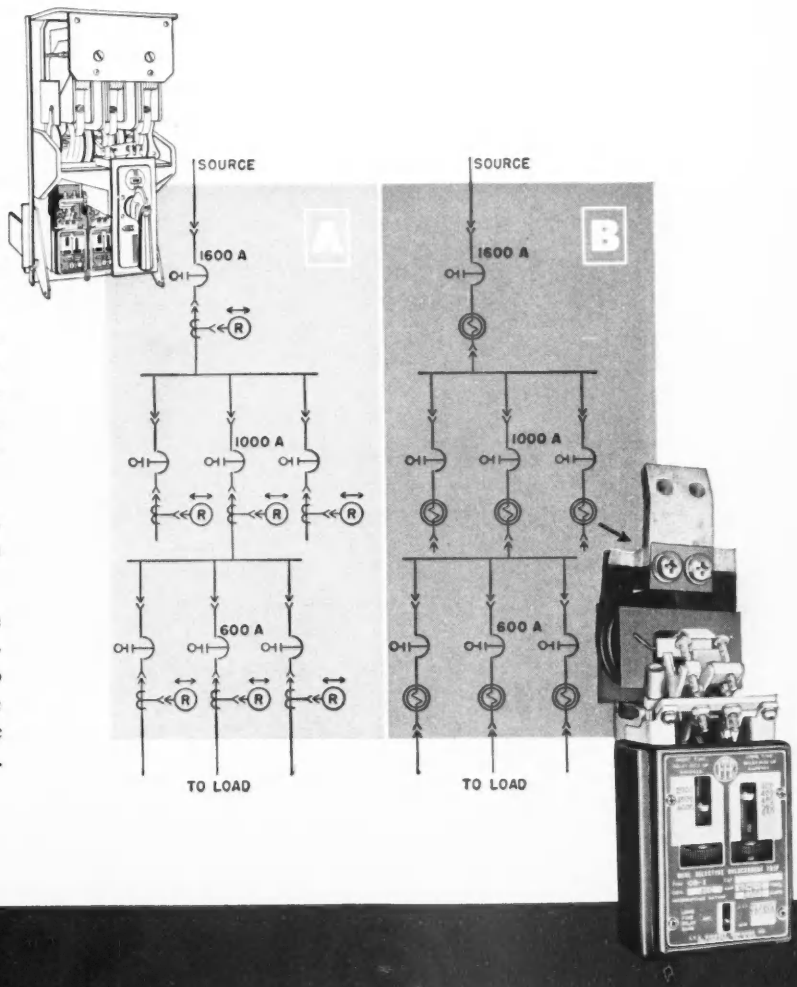
For the *utmost* in service continuity... I-T-E *Selective Tripping*

For those 600-volt switchgear applications in which absolute continuity of service is essential, I-T-E offers an advanced selective-trip device which mounts as an *integral* part of the circuit breaker.

By allowing the circuit breaker closest to a fault to open *first*, while other breakers remain closed, the selective-trip device *localizes* trouble. Thus, batch processes and other critical loads are insured against costly and unnecessary shutdown.

Through use of simple, compact I-T-E selective-trip devices, plants can realize an initial cost saving as high as *60%*!

Although Systems A and B (right) provide the same high degree of selective-trip protection, System B actually costs far less to install. I-T-E Direct-Acting Dual-Selective Overcurrent Trip Devices eliminate separate relays, save space, and reduce maintenance.



I-T-E CIRCUIT BREAKER COMPANY

and if DIRECT CURRENT is in the picture...

THE I-T-E MECHANICAL RECTIFIER GIVES YOU HIGHEST EFFICIENCY:

96%—and higher—from a-c line to d-c bus!

THE SAME INCOMING POWER —BUT 10% MORE CHLORINE!

Fields Point Manufacturing Corp., Providence, R. I., credits two I-T-E Mechanical Rectifiers for this substantial boost in production. Here is an excellent source of savings on power costs.

To obtain the highest rectification efficiency possible, I-T-E engineers have:

(1) taken the most efficient method for converting ac to dc—by mechanical switching; and then

(2) designed *equipment* to provide the highest efficiency obtainable with this method.

The result: almost ideal rectification!

A compact unit, easy to install and operate, the I-T-E Mechanical Rectifier gives top efficiency over the low 50 to 400 v. range—and from 25% to 125% of rated load.

The Rectifier is being used to advantage on continuous heavy-current d-c applications—in chlorine manufacturing, metal refining, and on motor load. *Thirty-seven* installed units—more than 200,000 amperes of connected load—prove the point!

FROM COAST TO COAST— STRATEGICALLY LOCATED I-T-E SALES OFFICES STAND READY TO SERVE YOU:

Birmingham, Ala.
Boston, Mass.
Buffalo, N.Y.
Butte, Mont.
Charleston, W. Va.
Charlotte, N.C.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Dallas, Tex.
Denver, Col.
Detroit, Mich.
El Paso, Tex.
Houston, Tex.
Indianapolis, Ind.
Jackson, Miss.
Jacksonville, Fla.
Little Rock, Ark.
Los Angeles, Calif.
Memphis, Tenn.
Miami, Fla.
Minneapolis, Minn.
New Orleans, La.
N. Kansas City, Mo.
New York, N.Y.
Omaha, Neb.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Ore.
San Francisco, Calif.
Santa Fe, N. Mex.
St. Louis, Mo.
Salt Lake City, Utah
Seattle, Wash.
Tucson, Ariz.
Washington, D. C.
Wilkes-Barre, Pa.

I-T-E CIRCUIT BREAKER CO.

19th and HAMILTON STS., PHILADELPHIA 30, PA.

Power Switching Equipment: R&IE Equipment Div., Greensburg, Pa.
Canadian Mfg. & Sales: Eastern Power Devices, Ltd., Toronto
Export Sales: Philips Export Corp., N. Y.

circuit breakers • switchgear • unit substations • isolated phase bus structures • mechanical rectifiers • electronic components • special products.

. . . better because

1 **Field tests show greater holding power.**

2 **Heavy duty construction • heavy gauge steel used throughout • deeply embossed and ribbed to withstand heavy loads without buckling.**

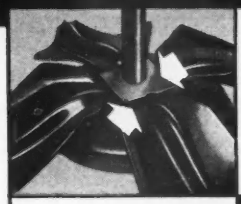
3 **Blades are correctly aligned with grain of steel to prevent tearing or breaking • gives a greater factor of safety.**

4 **Easier to install because blades are shaped to glide smoothly into the earth.**

PL-52-8

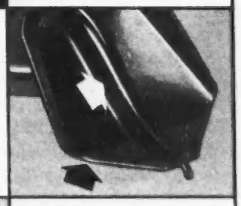
SEND FOR FREE SAMPLE

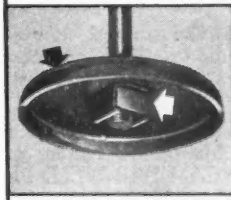
Also Standard P-L 4-Way and 2-Way Anchors available in 8″ diameter with 100, 115 or 135 sq. inch expanded area. P-L Anchors do an excellent job and can be installed easier in all types of soil . . . outstanding performance where rocks or other obstructions often cause failure of other types of anchors.



Heavy Drive-Plate takes driving force of spreading tool. Blades are extra wide at center of anchor to prevent breaking or buckling.

Blades are deeply ribbed and flanged for extra strength and rigidity. Sharp edged blades are properly curved to glide smoothly and easily into solid, undisturbed earth.





Base plate stamped from extra heavy boiler plate with sharp radius flange and embossed center hole for extra strength. Nut retainer acts as washer giving double thickness under nut. Will take 1″ rod.

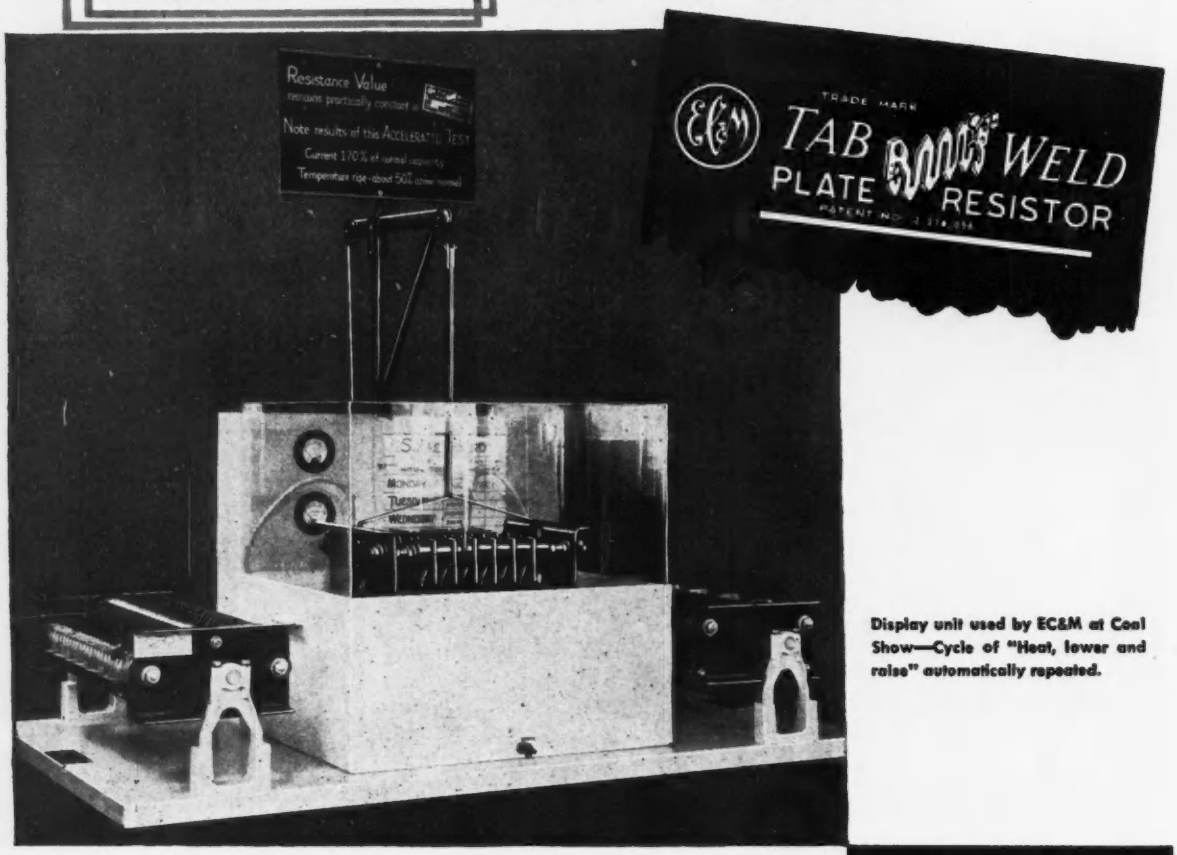
10″ diameter, 200 sq. in. expanded area. Compact and easy to install. Shipped completely assembled in one piece. No loose parts to fall off.

PIEPER-LILLARD, INCORPORATED

122 NORTH KIRKWOOD RD. ST. LOUIS 22, MISSOURI

TELEPHONE TERRYHILL 3-2525

harsh test fails to harm



Display unit used by EC&M at Coal Show—Cycle of "Heat, lower and raise" automatically repeated.

section OVERHEATED and quickly cooled in water about 1000 times—and no failure of any part

The severest service application would never subject a resistor-bank to the test given the above 100-ampere (continuous-rating) EC&M TAB-WELD Resistor section. Heating was accelerated by applying current 70% above normal, causing temperature to rise about 50% above rated rise in a short time. The resistor was then quickly immersed in water. Repeated about 1000 times, this EC&M TAB-WELD Section operated without attention.

Ohmic value was the same at the end of the test as at the beginning—the current-carrying path remained intact—no tightening of end-clamping nuts was needed—there was no burning at grid eyes or at tap plates.

For topmost efficiency in resistors for starters, controllers, battery-charging panels, test-panels, smoke precipitators and similar applications, investigate EC&M TAB-WELD Plate Resistors. Bulletin 942 gives complete facts. Write for a copy.

TEST DATA

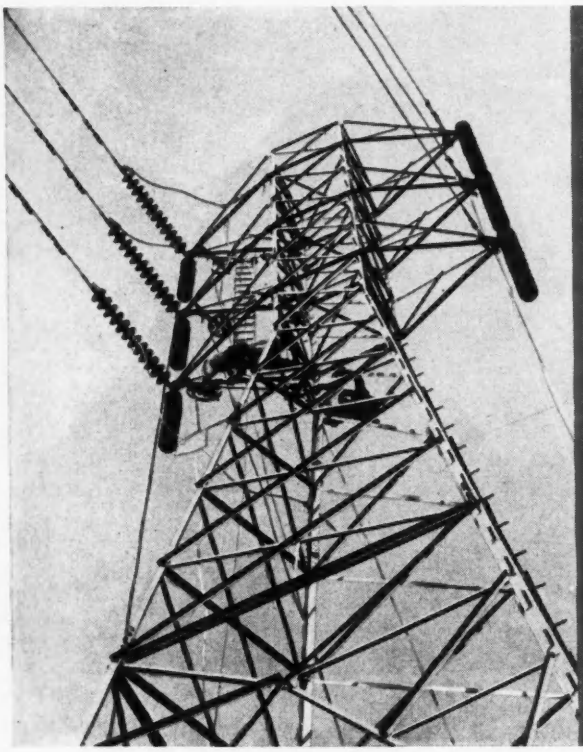
Ohms at start	.244
Ohms after 1000 operations	.245
Current used (average)	170 amps.

Temperature of resistor about 550° C. before immersion

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

REDUCE COSTS with ACSR

You reduce costs when you specify Aluminum Cable Steel Reinforced because: Aluminum costs less than copper. Aluminum is light in weight; it strings easier and faster—helps cut installation costs. The combined lightness and strength of ACSR makes possible longer spans. Fewer poles and towers are required. ACSR gives years of trouble-free service. For example, its low ice- and wind-loadings keep maintenance and repair costs to a minimum.



GREATLY REDUCE COSTS with Kaiser Aluminum ACSR

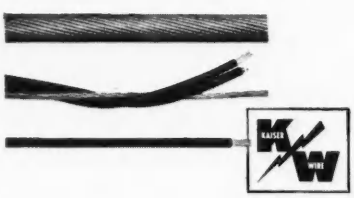
You greatly reduce costs when you specify Kaiser Aluminum ACSR because you benefit from fully-integrated field, engineering, and laboratory services available to help you make better installations at lower cost. Here's a partial list of what these services include:

Field Service—Kaiser Aluminum field men with years of transmission line experience work with your crews on stringing jobs. They suggest cost-cutting methods and techniques, and make regular inspections as work progresses.

Engineering Service—Kaiser Aluminum engineers go to work in the planning stage of your job, meet with crews to discuss latest techniques. They help solve specific problems as they arise, call in specialists where needed, furnish sag-and-tension charts upon request.

Laboratory Service—Kaiser Aluminum laboratories make continuous studies of accessories and fittings. Thus, we can recommend accessories and installation procedures designed to give you maximum service and economy. They also offer assistance on phases of your operations requiring fundamental research and they continually check Kaiser Aluminum conductor to insure consistent high quality.

You get this *complete service at no extra cost* when you specify Kaiser Aluminum conductor. Act now! Contact any Kaiser Aluminum office in principal cities, or one of our many distributors. Request these free pamphlets: 1) Tips on making good connections with aluminum conductors, 2) applications of Kaiser Aluminum Triplex Cable. Kaiser Aluminum & Chemical Sales, Inc., Oakland 12, California.

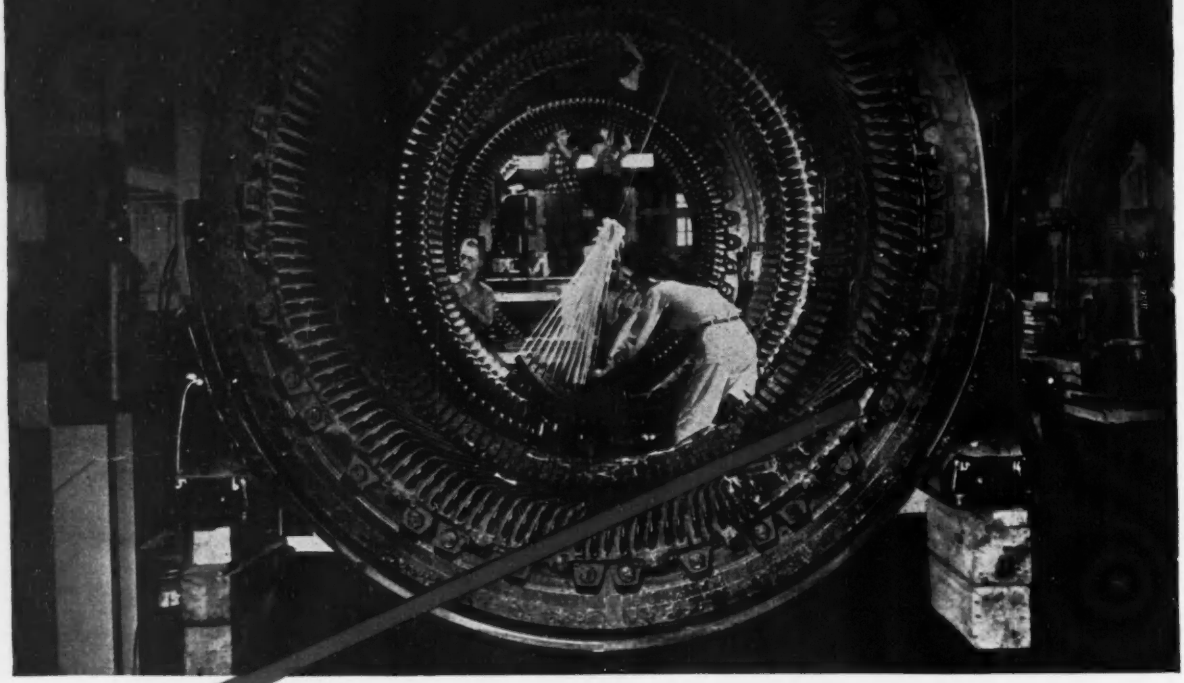


Kaiser Aluminum

setting the pace—in growth, quality and service

SOLID AND STRANDED NEOPRENE AND POLYETHYLENE COVERED CONDUCTOR
SELF-SUPPORTING TRIPLEX CABLE • ACSR • ALL ALUMINUM CONDUCTOR

THE PROBLEM: changes in line voltage characteristics of synchronous converters



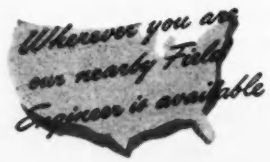
National has the answer

National engineers weren't stumped when a customer needed increased voltage from four synchronous converters. National redesign, made effective by National rewinding and National insulating materials, produced the required increase without loss of capacity.

In answer to another synchronous converter problem, National engineers proposed substantial voltage reductions which resulted in a 26% increase in the capacity of the National-rebuilt sets.

National engineers can redesign your apparatus to enable it to meet changing requirements. National craftsmen, working with National materials, can handle any rewinding job. National field engineers will supervise on-the-spot rebuilding of equipment too big to ship.

If you have a problem with any piece of rotating electrical equipment, it will pay you to consult National.



NATIONAL ELECTRIC COIL COMPANY

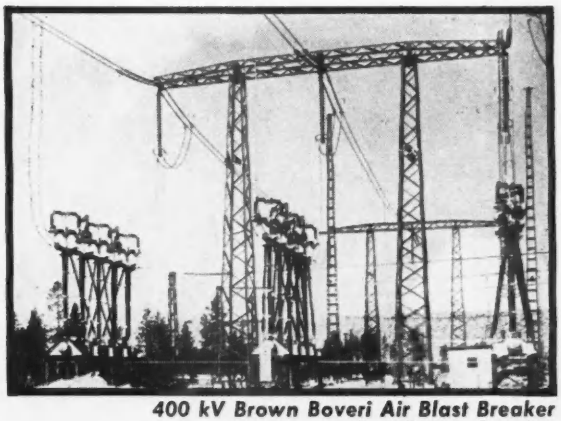
COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

GET ALL THE FACTS—

THEN SPECIFY

BROWN BOVERI AIR BLAST BREAKERS



400 kV Brown Boveri Air Blast Breaker installed in Sweden

- **HIGH INTERRUPTING CAPACITY**—Up to 15,000 kVA at 230 kV
- **HIGH CURRENT CARRYING CAPACITY**—Up to 4,000 Amps at 7 5 kV
- **HIGH SPEED**—3 cycles, all voltages, 7 5 to 230 kV, if required
- **RAPID CLOSING**—Available for all voltages, 7 5 to 230 kV
- **POSITIVE INTERRUPTION UNDER ALL CONDITIONS**—Normal load—short circuits—magnetizing and charging currents.
- **SAFETY**—No secondary damage even if highly overstressed.
- **AMAZINGLY LOW INSTALLATION COST**—Duration—and cost—of installation is only about one-half that of conventional breakers.
- **RAPID & EASY INSPECTION**—Any vital part, including main contact, is easily accessible . . . can be removed for inspection and re-installed by one man in less than 10 minutes.
- **MINIMUM MAINTENANCE**—Main contacts are good for 100 full-capacity interruptions without maintenance.
- **PROMPT DELIVERY & LOW INITIAL COST.**

With facts like these before them, it is no wonder that more and more executives and engineers of leading utilities, cooperatives and industrial organizations are using Brown Boveri Air Blast Breakers.

It will pay you to get the full details. Mail coupon below, today.

BROWN BOVERI

Brown Boveri Air Blast Breakers (indoor and outdoor) are available from 230 kV down to 7.5 kV covering the full range of A.S.A. standards.

Brown Boveri Corp., 19 Rector St., N. Y. C. 6
Please send me specifications and details on your ☐ indoor ☐ outdoor air blast breakers kV_____ Amps._____ kVA_____.

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

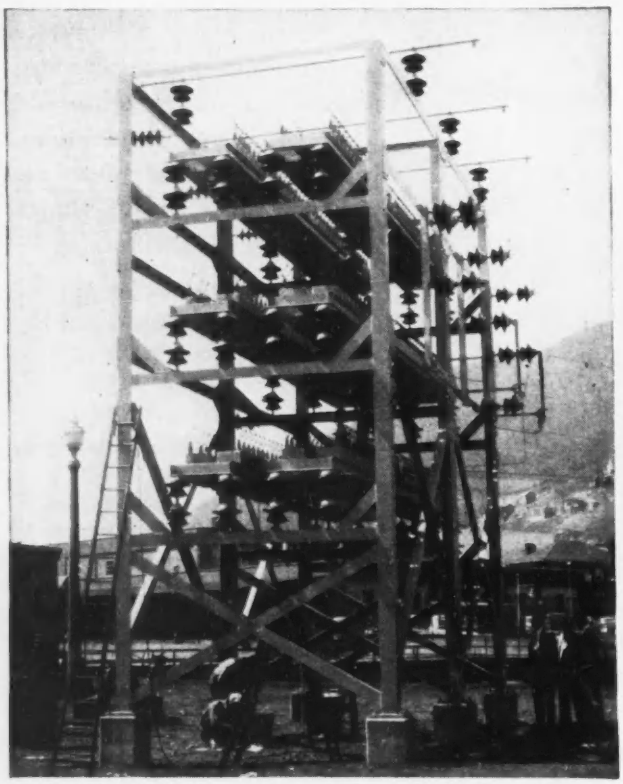
Progressive Engineers and Skilled Craftsmen for over 50 years

BROWN BOVERI CORPORATION
19 RECTOR STREET, NEW YORK 6, N. Y.

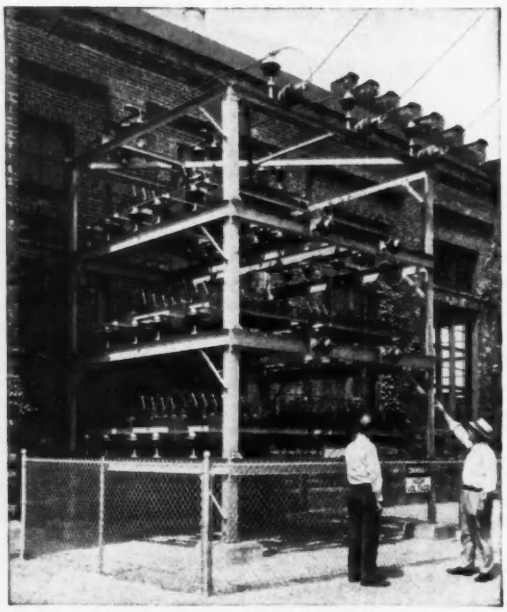
WORLD'S HIGHEST-VOLTAGE SHUNT CAPACITOR BANK at Bonneville Power Administration's Albany, Oregon substation. View shows one of the two outdoor open rack-type capacitor banks, rated 16,200 kvar, 124 kv.

G-E High-Voltage

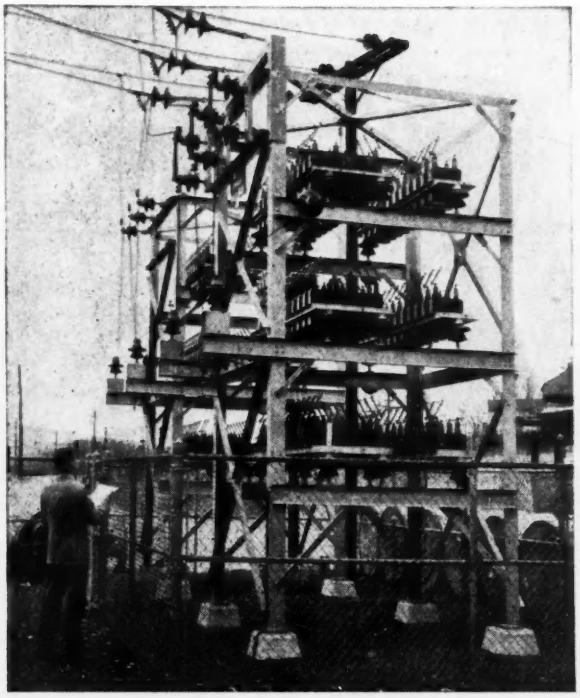
UTILITIES INSTALL MORE



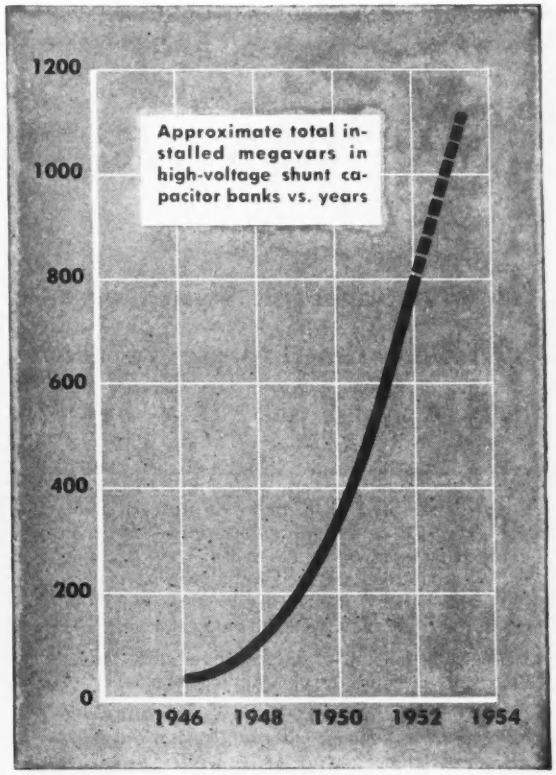
FIRST HIGH-VOLTAGE BANK completely supplied by General Electric is installed on the system of Appalachian Electric Power Co., Logan, W. Va. This Pyranol* capacitor bank is rated at 9900 kvar, 46 kv.



ONE OF MANY BANKS installed on Ohio Edison Co., high-voltage lines. This open rack-type installation, at Port Clinton, Ohio, supplies 5250 kvar, is rated 34.5 kv.



GROWING POWER NEEDS of New England Electric System are being met economically by installations such as these two banks of 21.6-kv capacitors located at a distribution substation.



Capacitor Banks Cut Transmission Costs

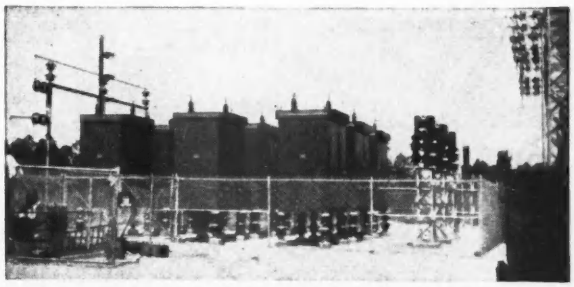
THAN 800,000 KVARS SINCE G-E PIONEERED FIRST COMPLETE BANK IN 1948

More and more utilities are installing capacitor banks to reduce voltage drop and to cut power losses on high-voltage lines. Although less than five high-voltage capacitor installations were in existence before 1948, today more than 100 banks have been installed, and at voltages as high as 124 kv. By improving voltage levels and reducing power losses, these banks provide for the transmission of larger blocks of power. Also, the banks are used to supply kilovars for unloading transmission and generating equipment where customers draw large amounts of kilovars from the system at subtransmission voltages.

Since pioneering early high-voltage installations, General Electric has supplied a majority of the 800,000 kilovars installed at voltages above 15 kv. The unequalled design knowledge thus gained enables General Electric to supply complete banks for your specific applications, whether of the field assembled or factory assembled "building-block" design.

It will pay to re-evaluate the use of capacitors on all parts of your system. A General Electric application engineer will be glad to work with you in determining what portion of your increased load can be economically supplied by capacitors. Call your nearest G-E Apparatus Sales Office, or write General Electric Co., Section 441-5, Schenectady 5, N. Y.

*Reg trade-mark of General Electric Co.



WORLD'S HIGHEST-VOLTAGE ENCLOSED BANK (66 kv) supplies 5950 kvar on Florida Power Corporation system. Blocking reactors in installation prevent attenuation of carrier signals.

You can put your confidence in—

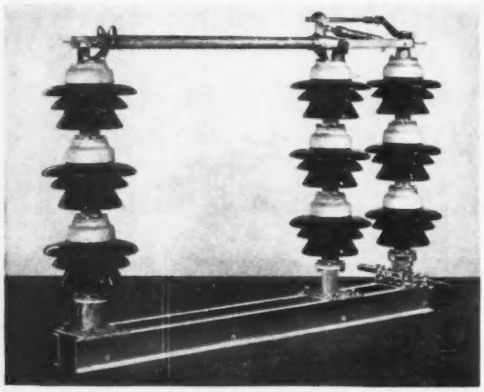
GENERAL ELECTRIC

90% less wear on switch parts

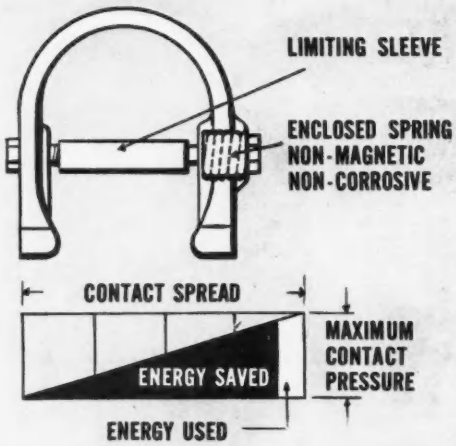
3E 8400 Airbreak Switch uses exclusive limiting sleeve for easy closure and long wear

When the blade pressure on an 8400 Airbreak Switch is released, a 3E patented limiting sleeve takes on 90% of the spring pressure. Thus when contact is closed again the switch has to rebuild only 10% of the balanced high pressure . . . the illustrations and graphs at the right show how 3E gives you these important advantages.

1. Minimum amount of energy required to set up contact pressure, resulting in minimum wear.
2. Practically no variation in contact pressure due to wear, or over or under mechanism travel.
3. Visible indication of correct contact pressure by free limiting sleeve.

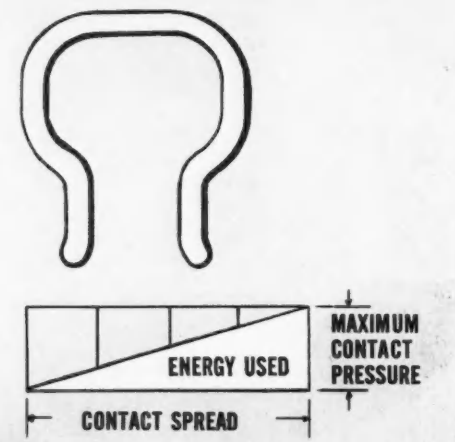


115 KV, 600 ampere, 8400 type Airbreak Switch.



MODERN 3E DESIGN

CONVENTIONAL DESIGN

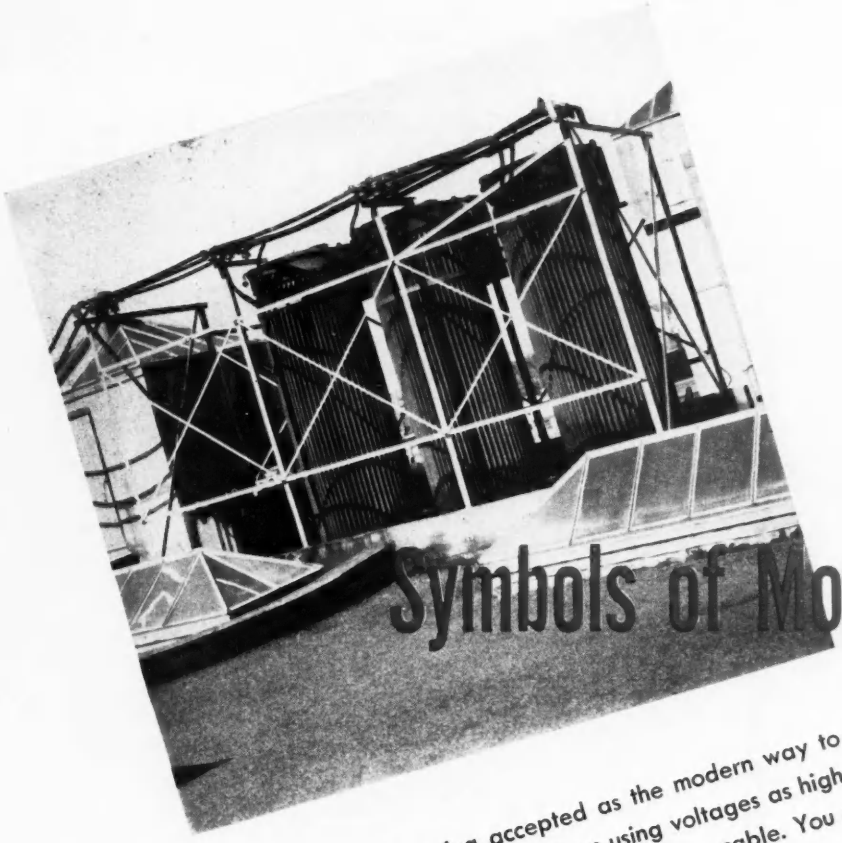


3E

FOR FULL DATA WRITE
FOR NEW BULLETIN 327

8400 AIRBREAK SWITCH

ELECTRICAL ENGINEERS EQUIPMENT CO. MELROSE PARK, ILL.



Symbols of Modernization

Unit load centers are rapidly becoming accepted as the modern way to distribute power inside an industrial plant. This frequently involves using voltages as high as 17,000 volts. That's too high a voltage to be trusted to just any ordinary cable. You can't afford mediocrity in these important cables. Simplex-ANHYDREX XX should be your choice.

Simplex-ANHYDREX XX is a product of Simplex research and development. It is an insulation that is absolutely "tops" in the high voltage field. It is designed to operate at a maximum of 176°F. (80°C.) copper temperature.

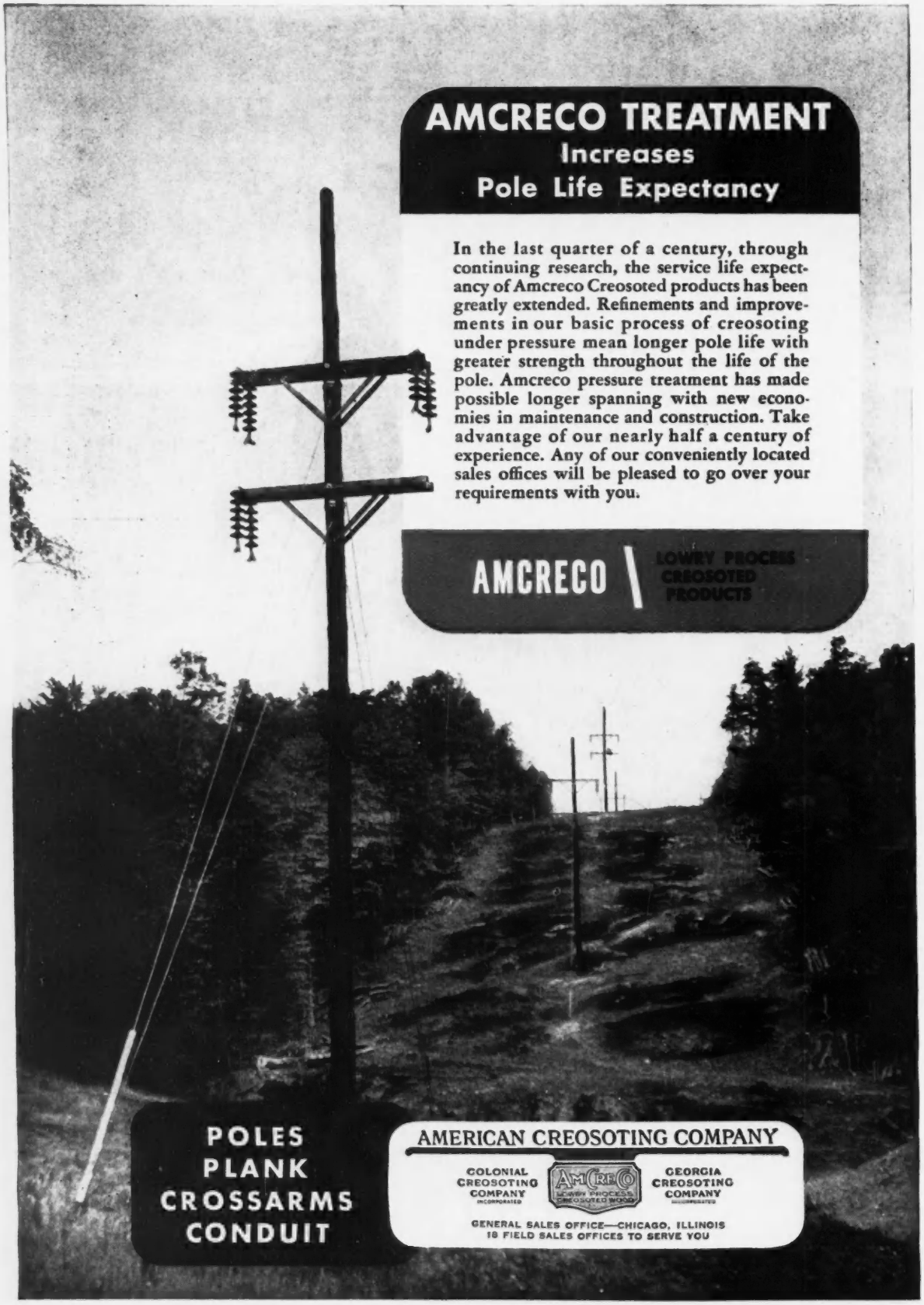
Simplex-ANHYDREX XX has all the properties you want in a high voltage rubber insulation. It withstands heat, ozone and aging, and it is guaranteed not to absorb more than 15 milligrams of water per square inch of exposed surface when tested in accordance with U. S. Coast Guard standards.

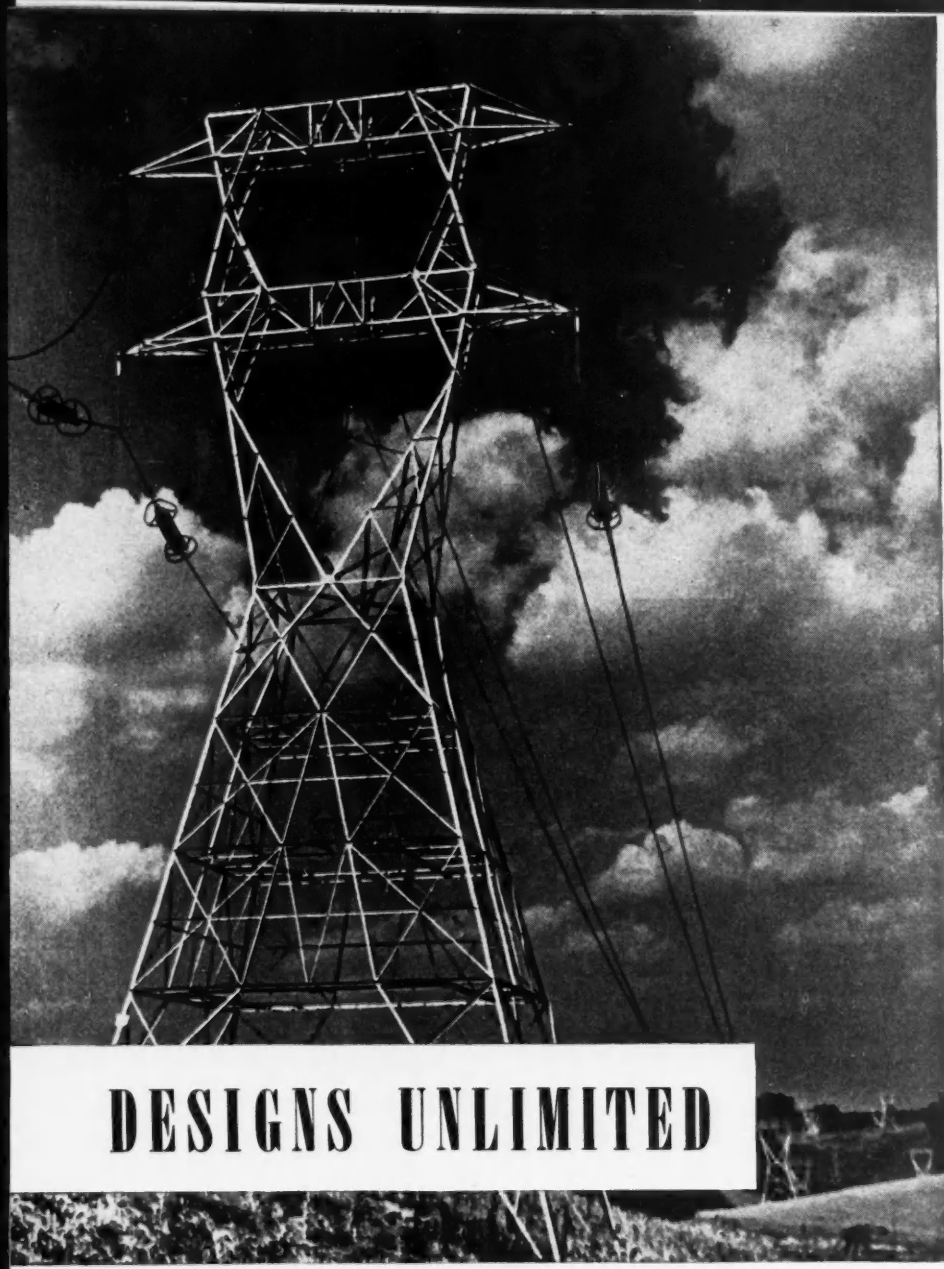
So far as we know it is the only insulation of its kind. Use it wherever you have a high voltage problem, whether the cables are to be installed directly in the earth, underground in ducts, underwater, or overhead supported from messenger wire.

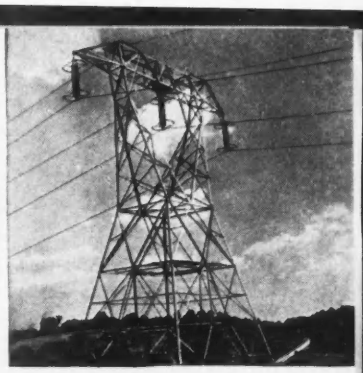
Simplex-ANHYDREX XX Cables are available in single and multiconductor styles for voltages from 2,000 to 17,000 V.W.P.

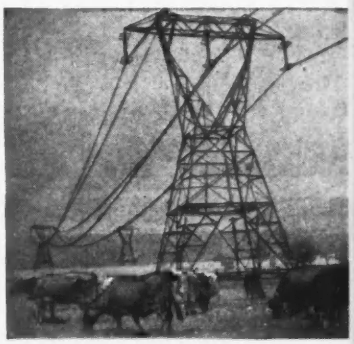
Simplex

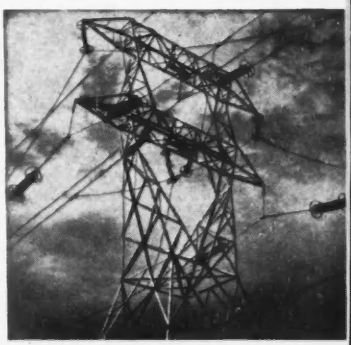
SIMPLEX WIRE & CABLE COMPANY, 79 Sidney St., Cambridge 39, Mass.

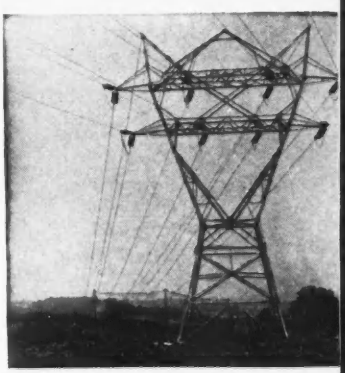

AMCRECO TREATMENT
Increases
Pole Life Expectancy
In the last quarter of a century, through continuing research, the service life expectancy of Amcreco Creosoted products has been greatly extended. Refinements and improvements in our basic process of creosoting under pressure mean longer pole life with greater strength throughout the life of the pole. Amcreco pressure treatment has made possible longer spanning with new economies in maintenance and construction. Take advantage of our nearly half a century of experience. Any of our conveniently located sales offices will be pleased to go over your requirements with you.
AMCRECO
LOWRY PROCESS CREOSOTED PRODUCTS
POLES
PLANK
CROSSARMS
CONDUIT
AMERICAN CREOSOTING COMPANY
COLONIAL CREOSOTING COMPANY INCORPORATED
AMCREO LOWRY PROCESS CREOSOTED WOOD
GEORGIA CREOSOTING COMPANY INCORPORATED
GENERAL SALES OFFICE—CHICAGO, ILLINOIS
18 FIELD SALES OFFICES TO SERVE YOU











DESIGNS UNLIMITED

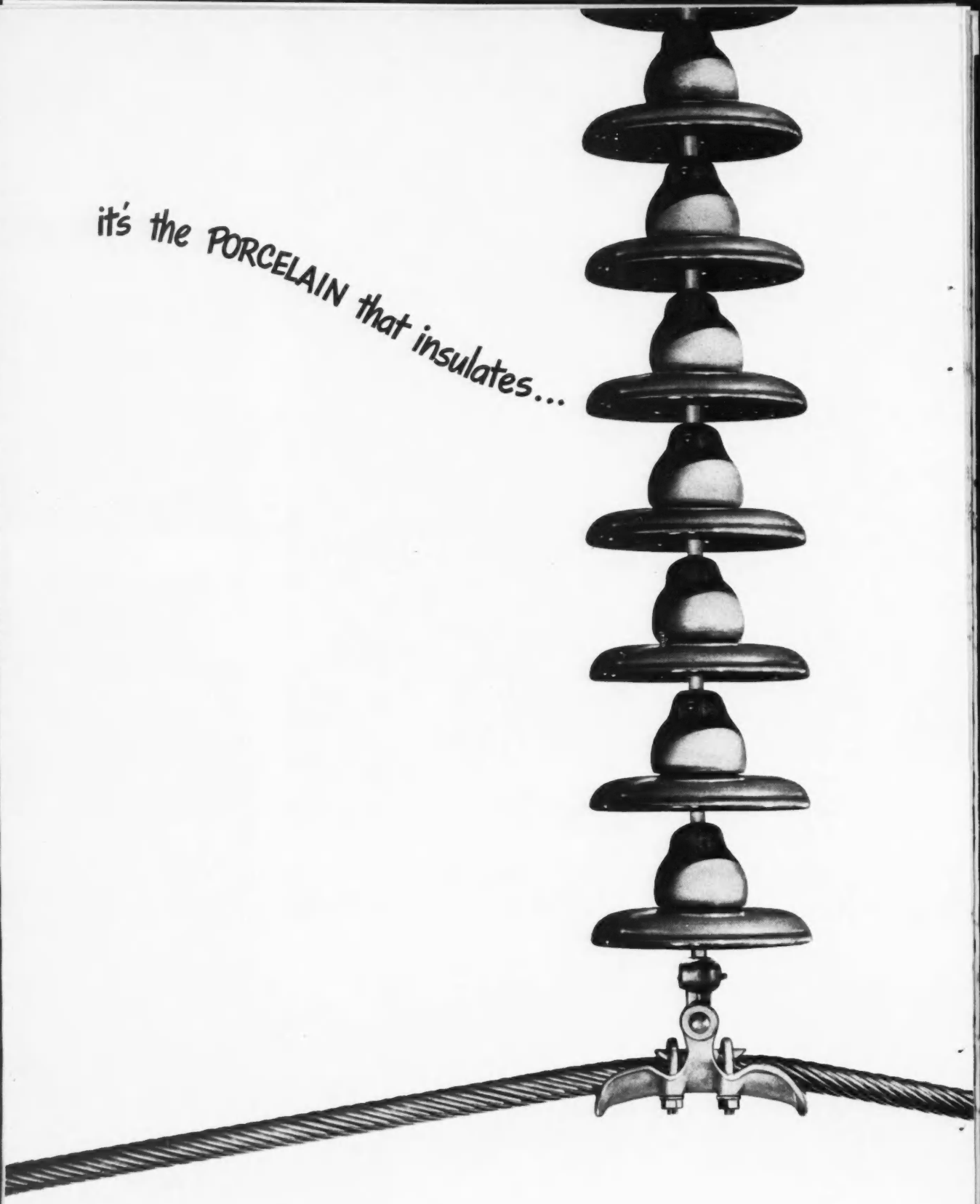
If your engineers have their own ideas on tower design, well and good. We will follow them to the letter and adhere closely to specifications. Your engineers realize, as we do, that despite general similarity no two towers are alike. Each tower must be designed for its particular location and purpose.

Let us apply our four decades of experience in building towers for any and all conditions of terrain and load to your power transmission problems.

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION
PITTSBURGH 22,
PENNSYLVANIA

BLAW-KNOX

it's the PORCELAIN that insulates...



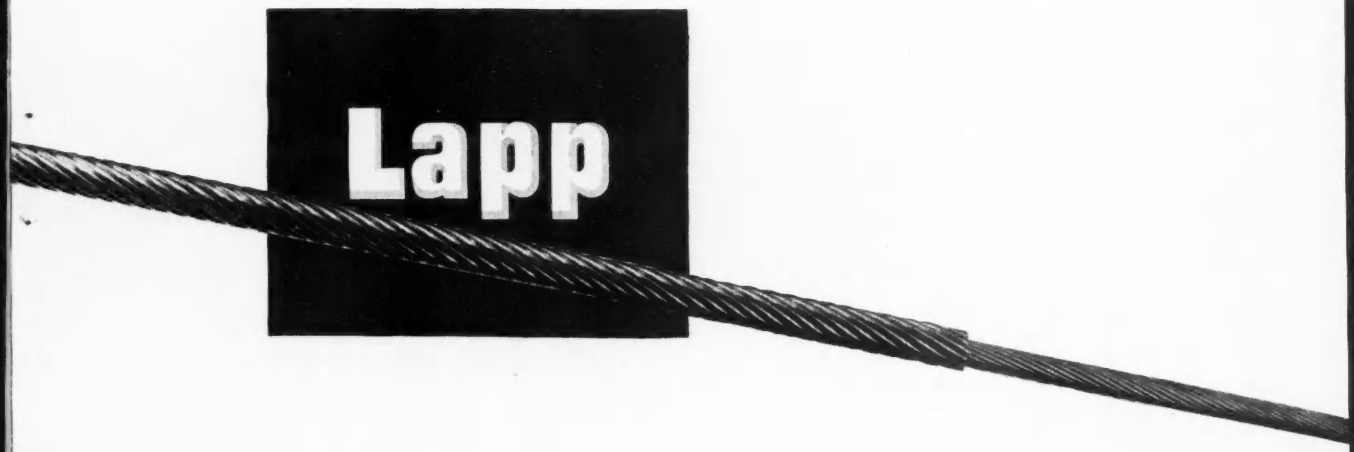
LAPP PORCELAIN

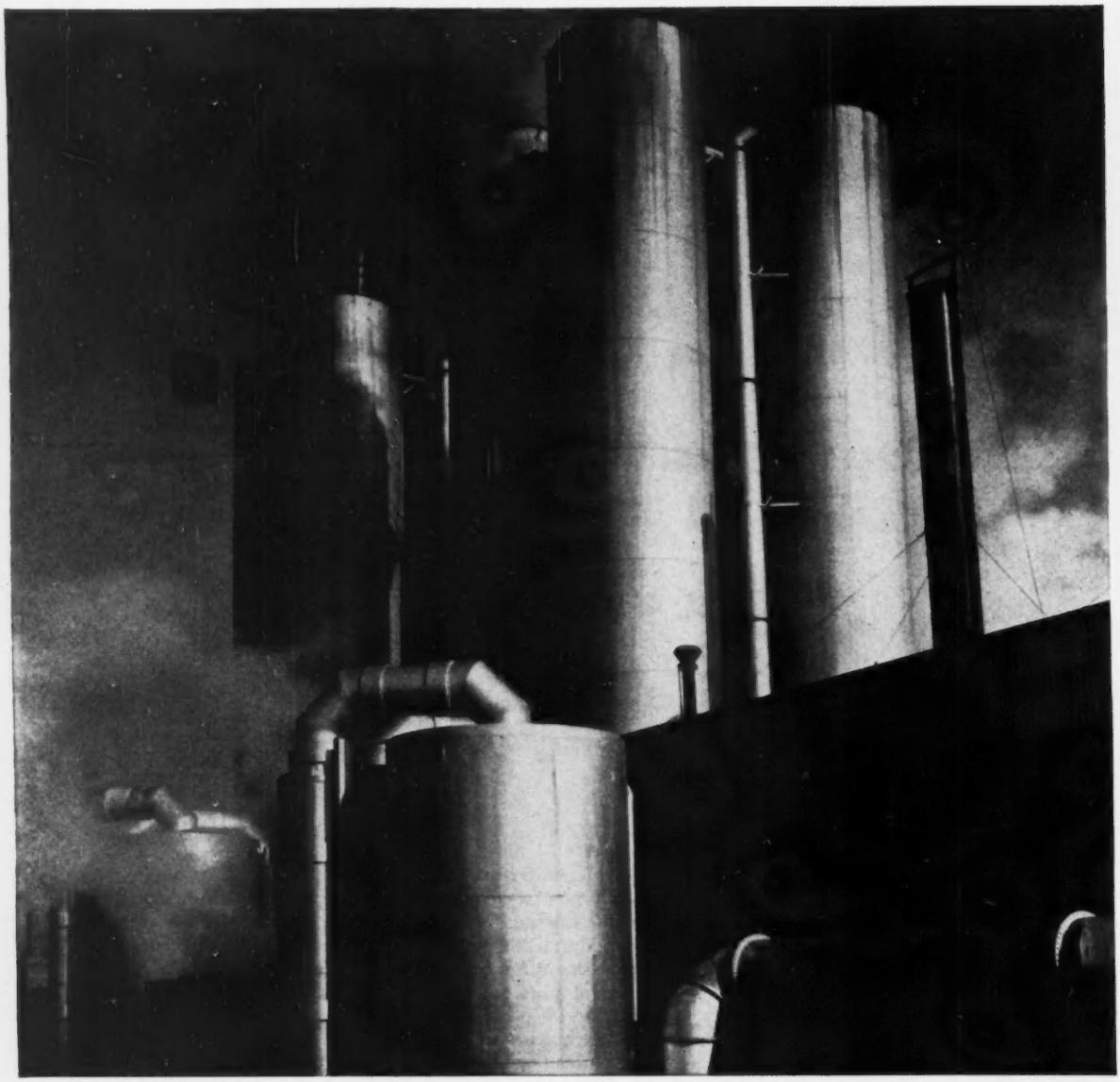
IS YOUR GUARANTEE

OF LONG INSULATOR LIFE

Insulator life depends on soundness of porcelain, and on assembly which gives it the best chance to live. For greatest insulator serviceability, look to the quality of the porcelain, and to assembly which recognizes the physical characteristics of the porcelain. Nowhere have these two requirements been the subject of more study, nor the object of more production care than at Lapp. The Lapp reputation for porcelain quality is ample basis for your confidence in the specification *"Lapp Suspension Insulators."*

Lapp Insulator Co., Inc., Le Roy, N. Y.





There's a special paint for places like this and it saves hundreds of dollars

When you get down to figuring how much it costs to paint a square foot of tank or stack, you find that the paint itself is only a small part of the cost. That's why experienced paint buyers select more quality aluminum paints for jobs like this than any other type.

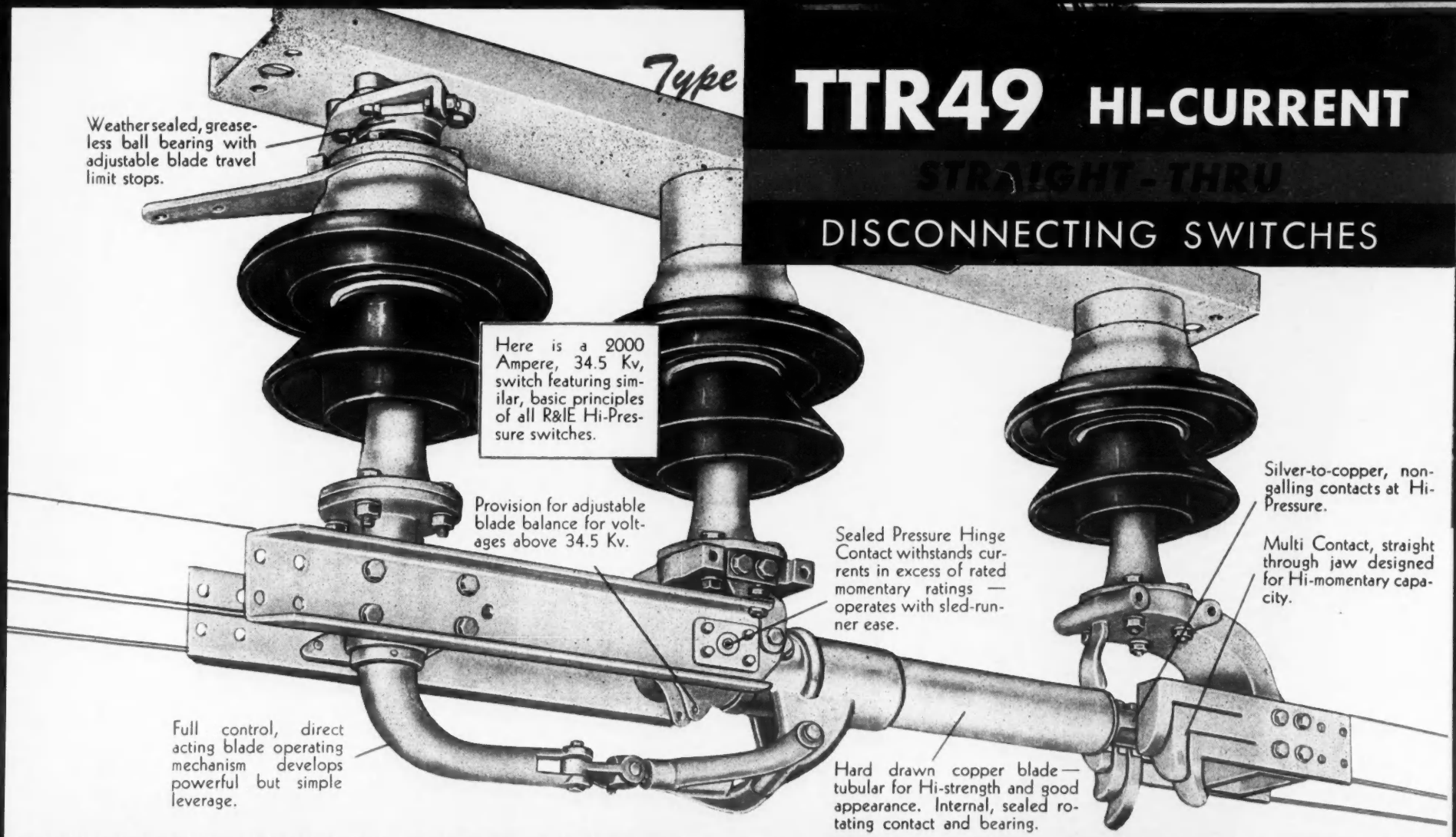
Because so much aluminum paint is used for these places, special formulas have been developed. Paints made to these formulas stand up longer under heat, cold, sun, rain and the kind of corrosive fumes you find around mills and factories.

We don't make paint. But we make the Alcoa Aluminum Pigments that are used in more aluminum paints than any other brand. So we want to be sure that you get full value from the aluminum paint you buy. It's just good business for us.

If you have a plant, or a stack, or storage tanks, or most anything else that needs paint that will last a long time, write us about your paint problem and we'll tell you what types of aluminum paints are best. We'll also send you a copy of *Painting with Aluminum*. It's packed with facts on selecting and using aluminum paints. Paint Service Bureau, Aluminum Company of America, 1787-H Alcoa Building, Pittsburgh 19, Pa.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA


Type
Weather sealed, grease-less ball bearing with adjustable blade travel limit stops.
Here is a 2000 Ampere, 34.5 Kv, switch featuring similar, basic principles of all R&IE Hi-Pressure switches.
Provision for adjustable blade balance for voltages above 34.5 Kv.
Sealed Pressure Hinge Contact withstands currents in excess of rated momentary ratings — operates with sled-runner ease.
Silver-to-copper, non-galling contacts at Hi-Pressure.
Multi Contact, straight through jaw designed for Hi-momentary capacity.
Full control, direct acting blade operating mechanism develops powerful but simple leverage.
Hard drawn copper blade — tubular for Hi-strength and good appearance. Internal, sealed rotating contact and bearing.

TTR49 HI-CURRENT

STRAIGHT-THRU

DISCONNECTING SWITCHES

BEFORE YOU BUY ANY SWITCH THAT GIVES YOU LESS —

Check the Facts on Type TTR49 — a new conception of Switch value

R&IE SWITCHING EQUIPMENT

DIVISION OF I-T-E CIRCUIT BREAKER CO., GREENSBURG, PA.

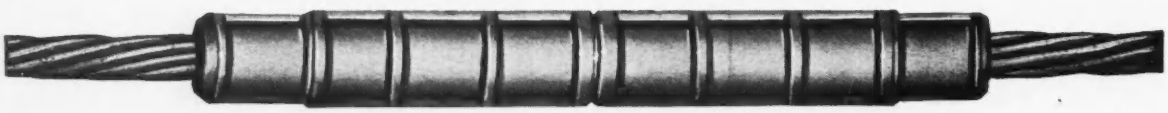
Nicopress

SPLICING SLEEVES

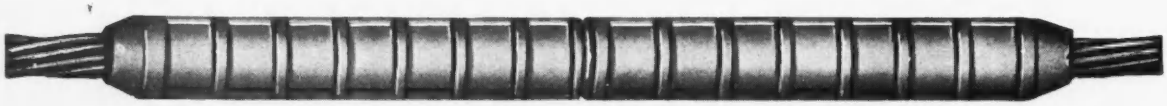
FOR LARGE CONDUCTORS AND HIGH-STRENGTH STRANDS

**Light in weight—Holds full strength of conductor—
High in conductivity**

Completed NICOPRESS Splice on 4/0 Copper Conductor



**Completed NICOPRESS Splice on 3/8" Extra High Strength
Copperweld Strand**



**Completed NICOPRESS Splice on 3/8" Extra High Strength
Galvanized Steel Strand**

Nicopress is the Registered Trade Mark of The National Telephone Supply Company

THE NATIONAL TELEPHONE SUPPLY COMPANY

The National Telephone Supply Company

5100 SUPERIOR AVENUE • CLEVELAND 3, OHIO

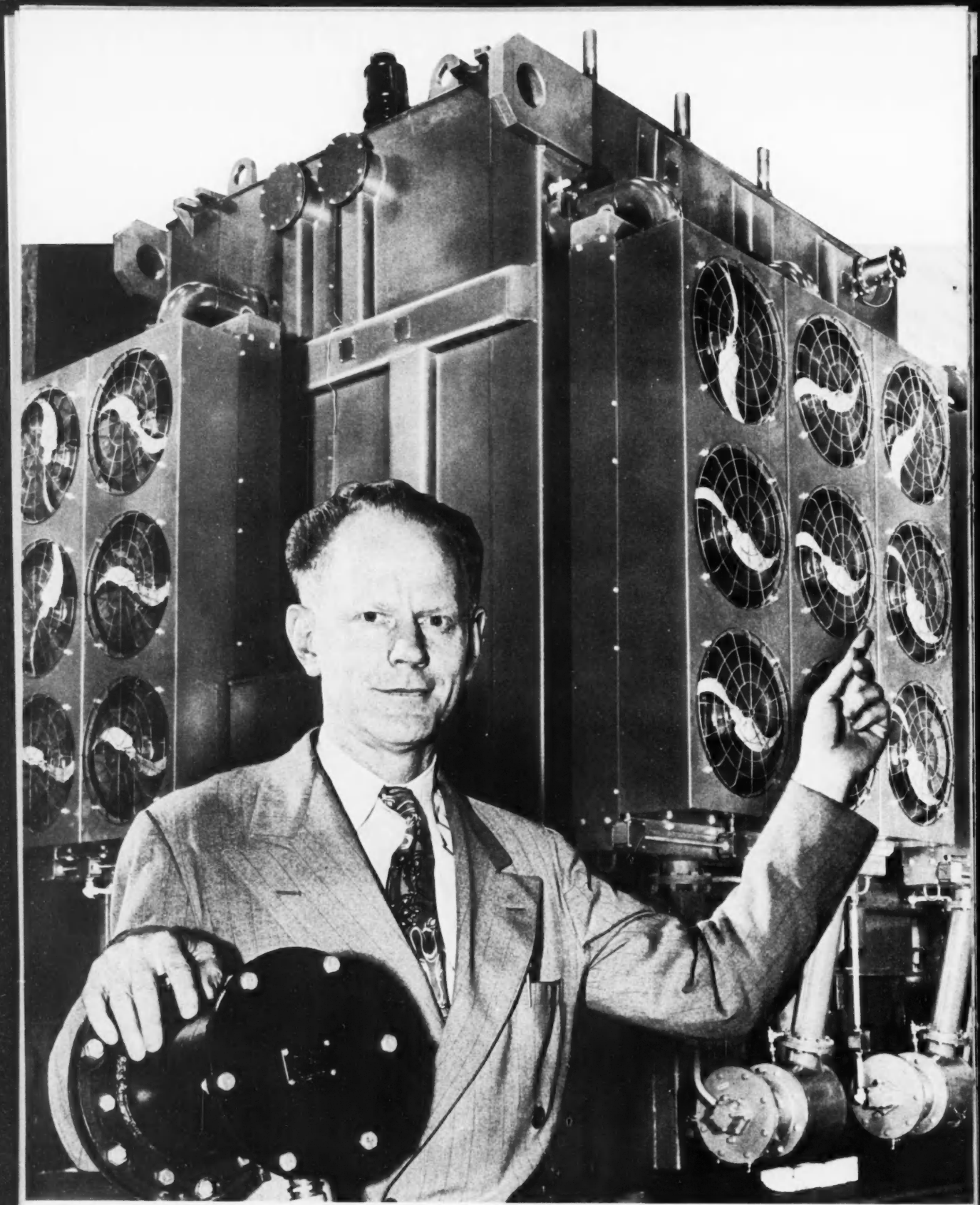
Canadian Affiliate: H. SLATER CO., LTD., HAMILTON, ONTARIO, CANADA • Export Distributors: INTERNATIONAL STANDARD ELECTRIC CORP., NEW YORK, N. Y.

Meet J. E. Barkle

Westinghouse Electric Utility Engineer. On the next seven pages, Mr. Barkle discusses your electrical equipment in terms of . . .

Protecting against the threats to your transmission system

Jack Barkle works on general projects for Western utilities where transmission lines are long and problems are challenging. A 15-year veteran of the Westinghouse Electric Utility Department, he is an expert in the field and has authored numerous AIEE papers on high-voltage transmission.



YOU CAN BE **SURE**...IF IT'S

"Here's E. C. Wentz, Manager Large Transformer Engineering Development, pointing out an accessory development."

New sudden pressure relay nips trouble in the bud

Westinghouse power transformers can now be equipped with a new relay that provides the long-sought answer to the problem of detecting transformer faults before extensive damage results.

Mounted on the side of the tank opposite the gas space, the new relay is designed for alarm-trip circuit closing on the occurrence of an internal fault producing an abnormal pressure rise. It will detect rates of change even smaller than two ounces per square inch per second. For steep-front increases of 40 pounds per square inch per second it will operate in ½ cycle.

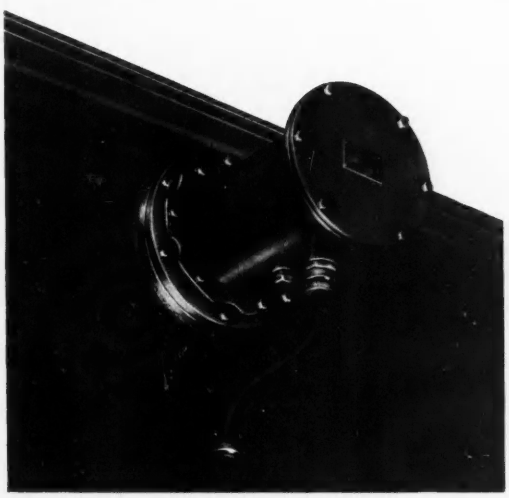
Disturbances such as inrush current, short circuits, impulse voltages or mechanical shock will not actuate the relay.

The relay operates by means of a pressure-actuated switch in a hermetically-sealed case which is isolated from the transformer gas space —except for a pressure equalizer. The equalizer permits normal transformer operation over its entire pressure range but throttles abnormal pressures to effect a pressure differential between the transformer and the relay case—thus operating the pressure switch.

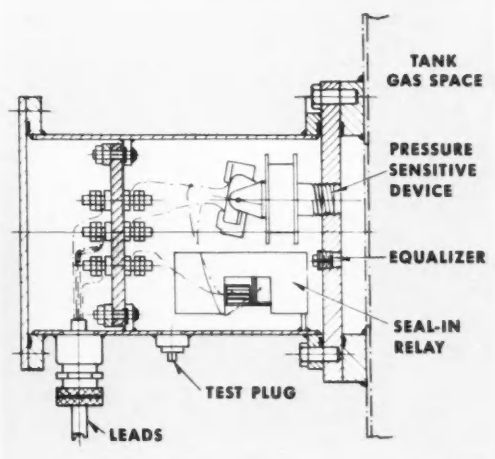
With such design improvements continually adding to Westinghouse power transformer protection, your transmission investment is assured of added reliability.

Why not investigate Westinghouse power transformers for application to your transmission system? You will find your nearby Westinghouse representative well-primed with helpful suggestions. Or write now for Booklet B-4142A, "Power Transformers for *All* Applications."

J-70696



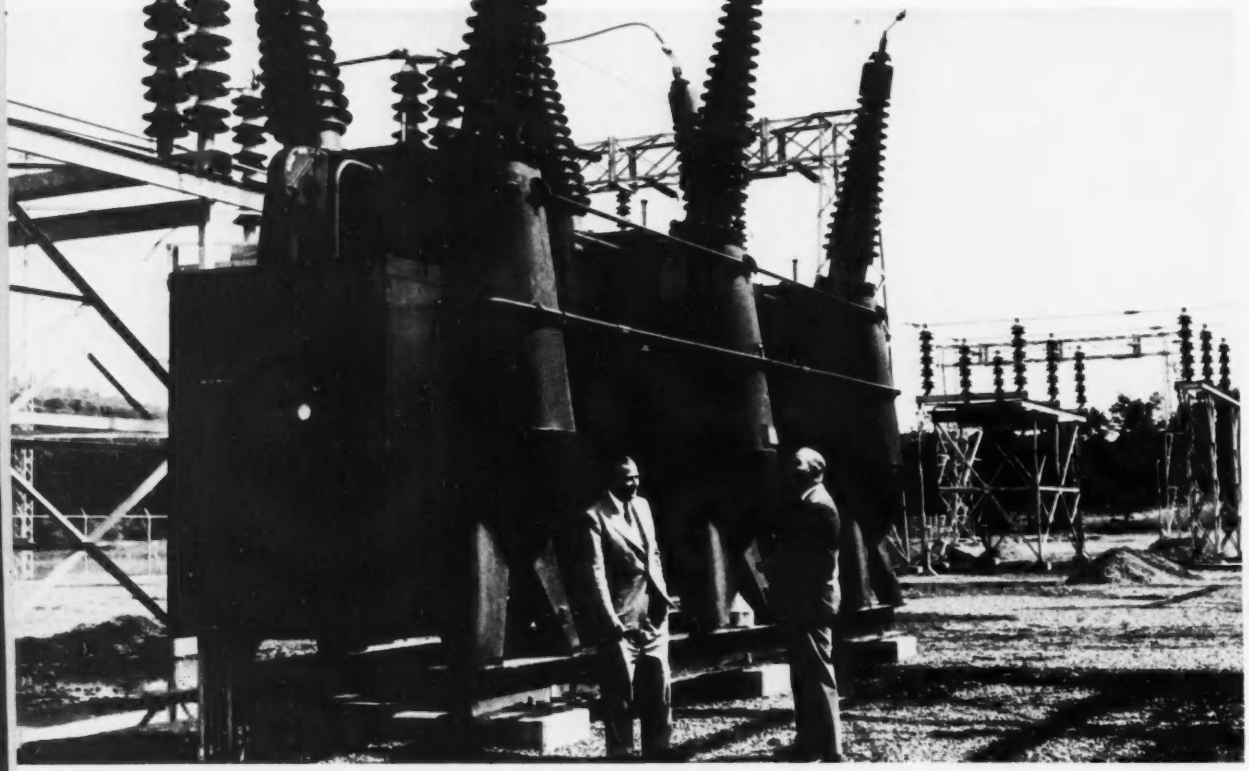
Sudden Pressure Relay installed on tank side near top cover and wired into the conduit-type tank bracing rib.



Internal view of relay showing its isolation from tank gas space, equalizer, pressure-sensitive device, seal-in relay.

Westinghouse

"Stanley Townsend of Pennsylvania Power and Light Company and Ralph Wyatt** of Westinghouse inspect an important new development . . ."*



Latest type breakers protect PP&L'S modern 230-kv system

Here in the Hosensack Station, Pennsylvania Power and Light Company chose the most modern breakers available today. Westinghouse Watchcase† Breakers, to protect their advanced 230-kv transmission.

Mr. Townsend liked the Westinghouse Watchcase Breakers because of their demonstrated interrupting ability. The heart of these breakers, the "De-ion®" grid, has been thoroughly tested and verified in the Westinghouse High Power Laboratory as well as by years of successful field service.

Pennsylvania Power and Light Company gained further advantages through the selection of these breakers. The reduced oil content of Westinghouse watchcase design did not require the installation of expensive oil handling facilities, but permitted the use of existing mobile oil handling equipment. Result: substantial savings in construction and maintenance costs. These 230-kv watchcase breakers are steel-skid mounted. The three tanks and operating mechanism are factory assembled on heavy I beams and shipped as a unit. As a result, they reduced installation time and expense.

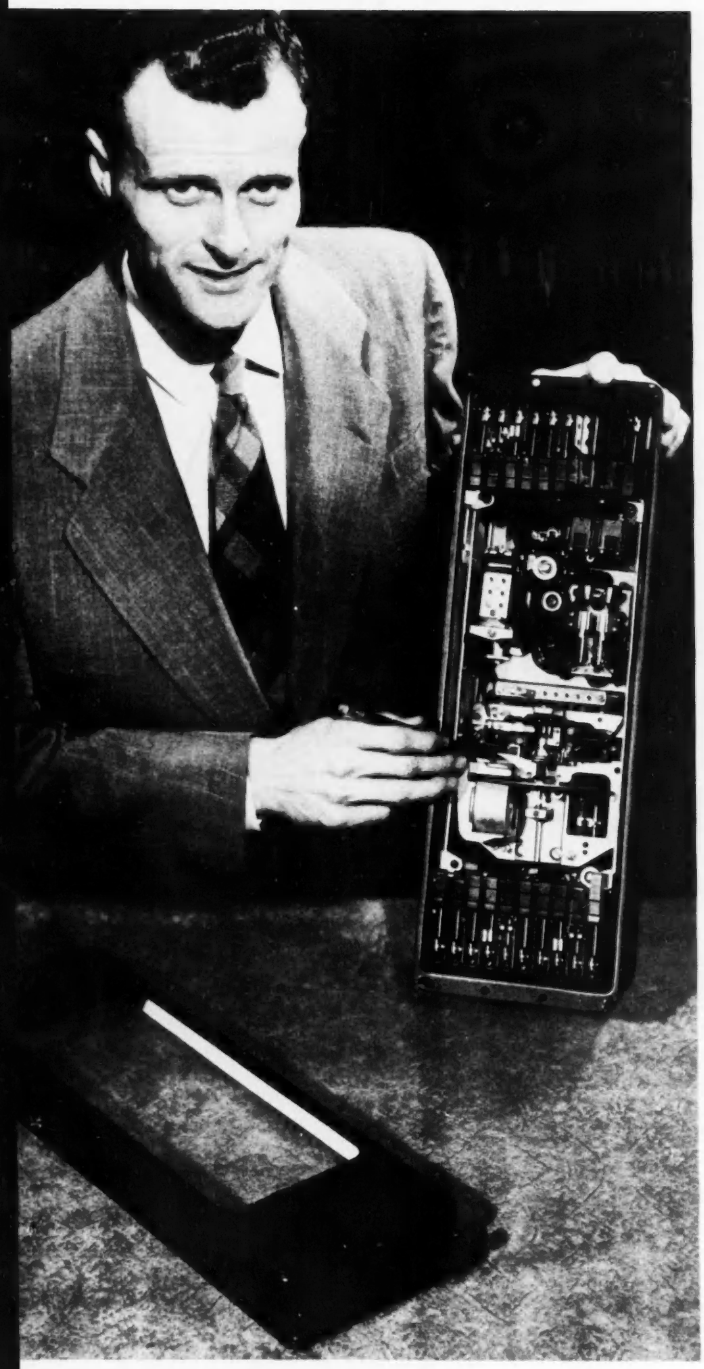
The AA-10 operating mechanism provides 20 cycle reclosing, and being mechanically trip free permits three cycle interruption either on an initial opening or following a reclosing. Write now for more information on the application of these modern breakers to your transmission systems. J-60833

†Trade-Mark

**Mr. Townsend is Electrical Engineer, Pennsylvania Power and Light Co.*
***Mr. Wyatt is Manager of the Westinghouse Allentown Office.*

YOU CAN BE **SURE**...IF IT'S

"Since relays stand guard over your transmission system, here is Bill Glassburn, Westinghouse Relay Engineer, with some good news on low-cost relay protection."



Now you can get lower cost relay protection for distribution feeders

High-speed clearing of phase faults on sub-transmission lines and distribution feeders at lower cost is now made possible by the development of Westinghouse HRZ relays. These relays help you guard against long outages and damage to your transmission system. They provide instantaneous fault protection for 80 to 90% of the line section, together with backup protection which can be more effectively coordinated with inverse overcurrent relays on adjacent line sections.

The type HRZ relay contains, all in one case, an instantaneous (HZ) element, an overcurrent (CO) element, a directional element, and auxiliary contactor switches. Operation indicators are also included to show whether tripping was due to the operation of the instantaneous impedance element or the time-delay overcurrent element.

Lower cost HRZ relays are designed for use on lines not protected by power line carrier relaying or similar more expensive equipment. They give utilities high-speed protection on installations which otherwise would be without it.

The HRZ relay is typical of the many engineering developments that have made Westinghouse a leader in the relay field.

Write to Westinghouse for more information on how HRZ relaying can be applied to your system.

J-40450

Westinghouse

"Jim Owens discusses a line of disconnecting switches with dependability designed into every detail . . ."*

See why these unusual switches give you unmatched system protection

These Westinghouse disconnects are designed with a combination of features not available today in any other switch. They give you unmatched protection. Here are the specific reasons why:

The troublesome problem of shunts on the live side has been eliminated on the RL, as on previous Type V switches, by ingeniously designed, high-pressure line contacts. These contacts are never broken. They're completely enclosed to protect against corrosive atmospheres and adverse weather conditions. The maintenance cost is low.

These switches are lubricated for life, with Oilite bushings on the live side and stainless steel bearings under the rotating insulators. The switches are mounted on formed-steel bases which house the bearing, so that there is no shaft extension. These bases provide large-area mounting surfaces. The contacts are multiple-line type with heavy silver.

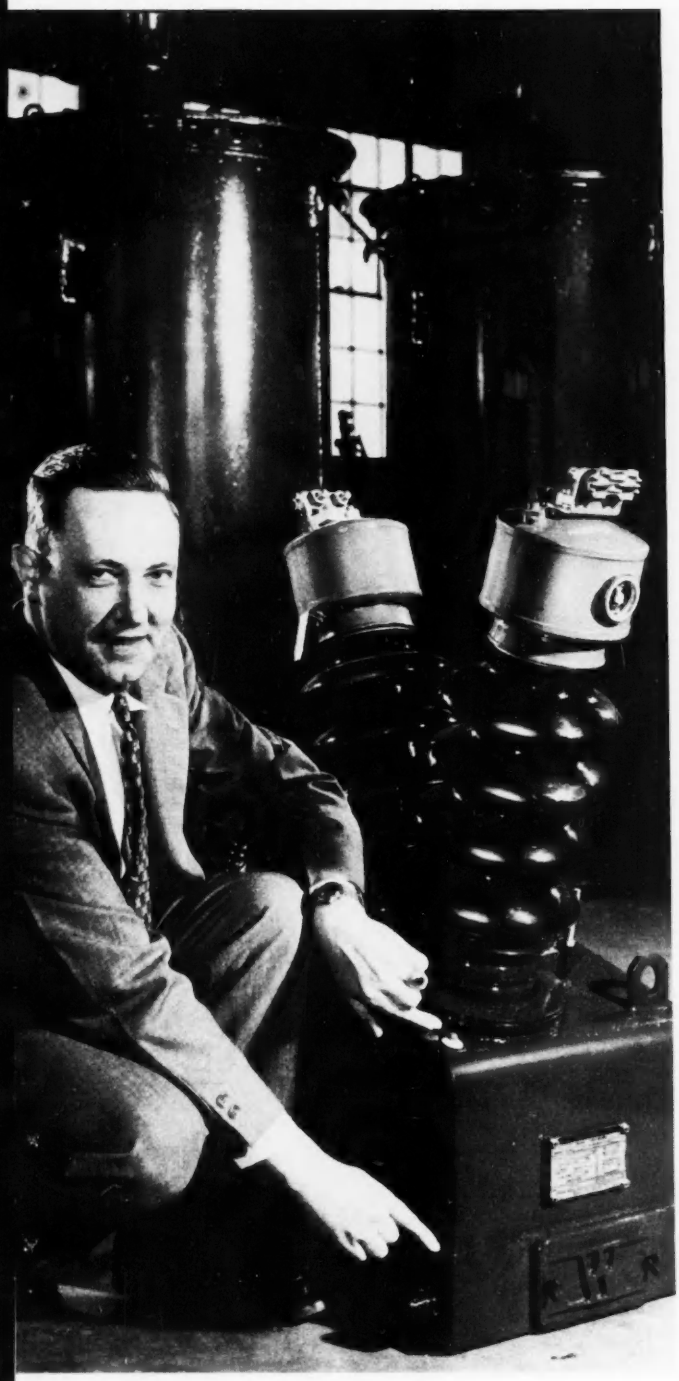
Where the use of a two-insulator, single-horizontal-break disconnecting switch is indicated, we invite you to compare the RL with any similar device.

Write now for more information. J-60834

**Supervising Engineer, Disconnecting Switch Section*

YOU CAN BE **SURE**...IF IT'S

"Newman Henry, Manager of Instrument Transformer Engineering, points out an important link in transformer protection . . ."



Accuracy hermetically sealed-in for long-term protection

The high accuracy of instrument transformers has a direct bearing on the reliable operation of protective devices on your transmission system. Therefore, it is *vital* that accuracy be built in—and sustained.

The high accuracy of Westinghouse instrument transformers is *hermetically sealed-in* by these processes:

1. All tank seams arc welded and air pressure tested
2. HV bushing flanges are rolled on to porcelain
3. HV flanges welded to tank
4. LV bushings solder sealed

The security of all joints of the complete vacuum-filled assembly is then proved by an oil-pressure test.

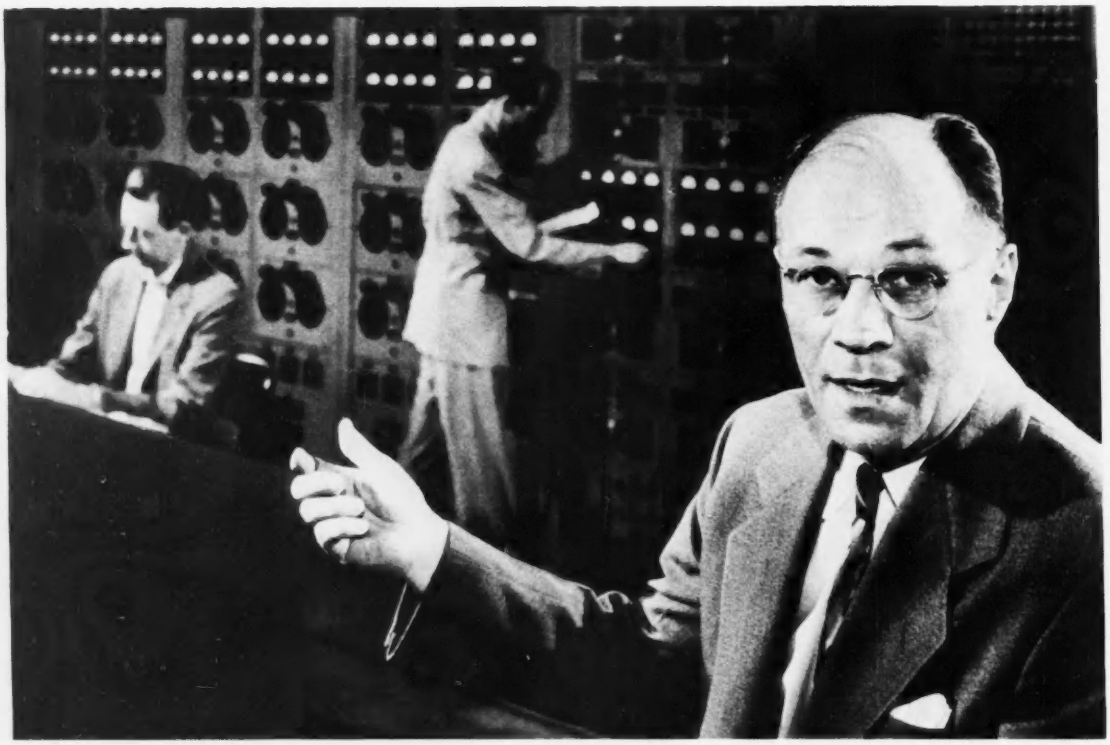
There are many other outstanding features of Westinghouse instrument transformers such as Hipersil® Cores, oxygen-free copper, controlled insulation power factor that make them the best transformers for your transmission system.

Your nearby Westinghouse representative is ready and willing to discuss more fully their application to your specific problem. Why not get in touch with him?

J-70697

Westinghouse

"Shown here at the network calculator in East Pittsburgh is L. L. Fountain of Switchgear Engineering. He discusses another unit . . ."*



World's biggest network calculator will solve mysteries of system protection

The world's biggest network calculator with 580 circuits is now being built at our East Pittsburgh works for seven major Middle Atlantic power companies. It will be installed at the Franklin Institute in Philadelphia and will go to work in 1954. The new unit will be the 30th calculator in the United States, of which Westinghouse has built the majority.

One big job of the new calculator will be to solve transmission protection problems for the seven utilities owning it. It is in effect a power system in miniature. A single-line diagram of the system under study is mounted on a translucent board. Small lights underneath indicate the circuits being metered. Sensitive instruments with automatic scale selectors show just what would happen under actual system operating conditions.

**Manager, Technical Section*

The a-c network calculator has made two great contributions to the industry. First, it is a tool which helps the utility engineer plan and design his system with assurance. Second, it has brought electric utility problems closer to the electrical manufacturer. Result: a better understanding and knowledge of the apparatus characteristics which are needed to provide well-designed and coordinated system performance.

★ ★ ★ ★ ★ ★

Write now for more information on calculator installations or on the products described on preceding pages. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. CP-5(1008)

YOU CAN BE SURE...IF IT'S

Westinghouse

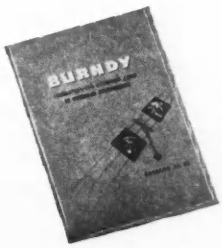
WHY IS THIS STRAIN CLAMP SPECIFIED FOR DEAD-ENDING?

DUW-A

In overhead distribution applications where clearance between phases is limited, this Burndy straight-line strain clamp insures rapid installation, dependable performance and easy re-sagging because:

- Superior alloys and structural design provide maximum strength, permit high tightening torque—with minimum bulk.
  Holding power on aluminum or copper conductors always exceeds 90% of rated breaking strength of the conductor, and in most cases equals the rated strength. (Can also be used on ACSR; refer to Burndy for details.)
- Maximum holding power — without injury to conductor. Saddle under U-bolts distributes clamping pressure uniformly. Tapered front end of groove permits gradual pickup of stress from conductor to clamp. Belled saddle and groove entrances prevent nicking or abrading the conductor strands.
- Long neck facilitates carrying through of jumper loop.
- Design eliminates pockets where water might accumulate —guarding against corrosion.

Aluminum cable to 1510.5 Mcm—Copper to 2000 Mcm.



Consult—"Connectors for Aluminum Cable in Overhead Distribution," Catalog AL53.

BURNDY

NORWALK, CONNECT. FACTORIES: New York • California **TORONTO, CANADA**

EXPORT: Philips Export Corporation

53-3

From the finest of the Western forests...

...comes the **finest** in **power transmission poles!**

Take Nature's proud creation—Western Red Cedar, give it science's most durable protection—Life-Span's end-to-end treatment, and you have the proved formula for strong, straight, lightweight power-line poles that give many *extra* years of trouble-free service.

And Life-Span Poles are really *clean*, always safe, easy to handle. Not only will they give trouble-free service through to obsolescence, but Life-Span Poles are bound to build plenty of good will for the companies who install them.

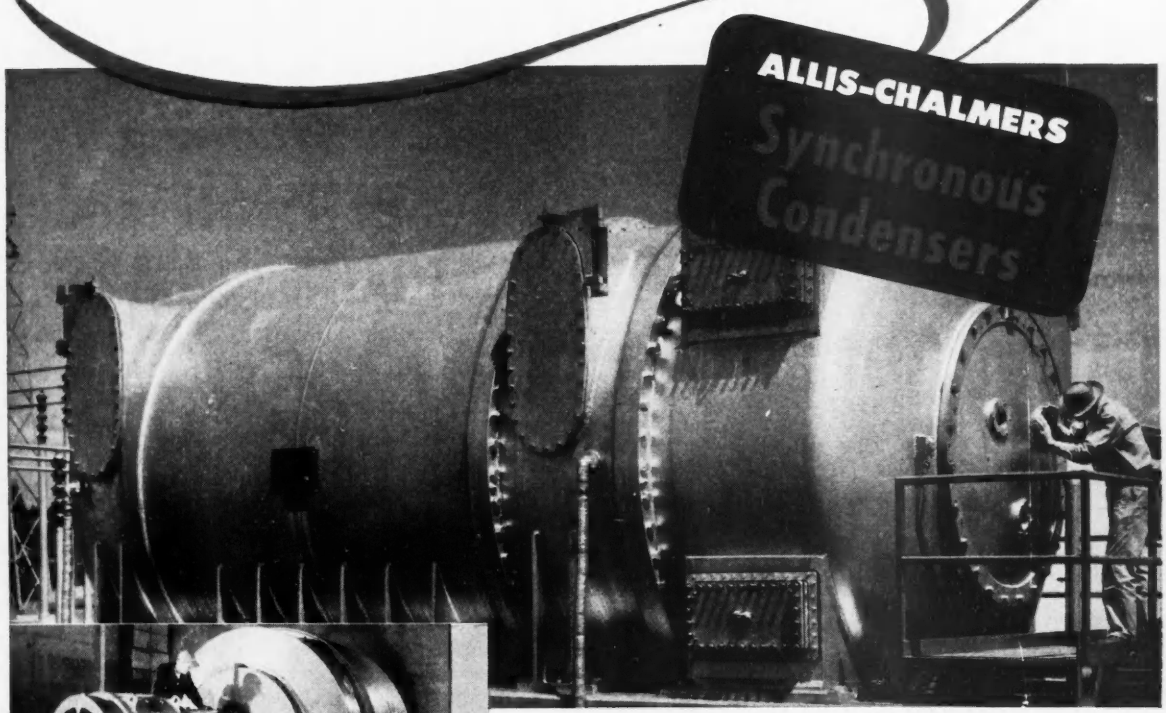
To be sure of the finest—specify Life-Span Western Red Cedar Poles in *your* construction jobs. Write for information today.

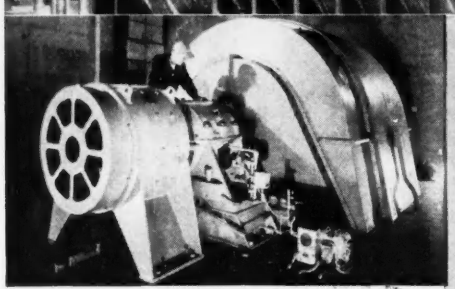
CONSOLIDATED TREATING COMPANY
MINNEAPOLIS, MINNESOTA

SOLD ONLY BY THE FOLLOWING:

- B. J. CARNEY & CO. Spokane—Minneapolis
- NAUGLE POLE & TIE CORP. Chicago, Illinois
- SCHAEFER-HITCHCOCK CO. Sandpoint, Idaho Suppliers for Joslyn Mfg. & Supply Co.
- PAGE & HILL, INC. Minneapolis, Minnesota 50 Church St., New York, N.Y.

Better than Rebuilding Transmission Lines





Pacific Coast system uses 50,000-kva hydrogen-cooled condenser (top view), and 20,000-kva air-cooled unit (bottom view).

Besides minimizing losses, hydrogen cooling results in a design suited to outdoor operation. Air-cooled units can also be built for outdoor use, and for industrial power-factor-correction applications.

Regulex amplifier control, which acts as both regulator and pilot exciter, is available for all synchronous condenser ratings.

Regulex is an Allis-Chalmers trademark.

FOR WIDESPREAD power systems, synchronous condensers can frequently be used in place of added or larger transmission lines. This is possible because, by supplying reactive kva, they assure efficient use of power lines.

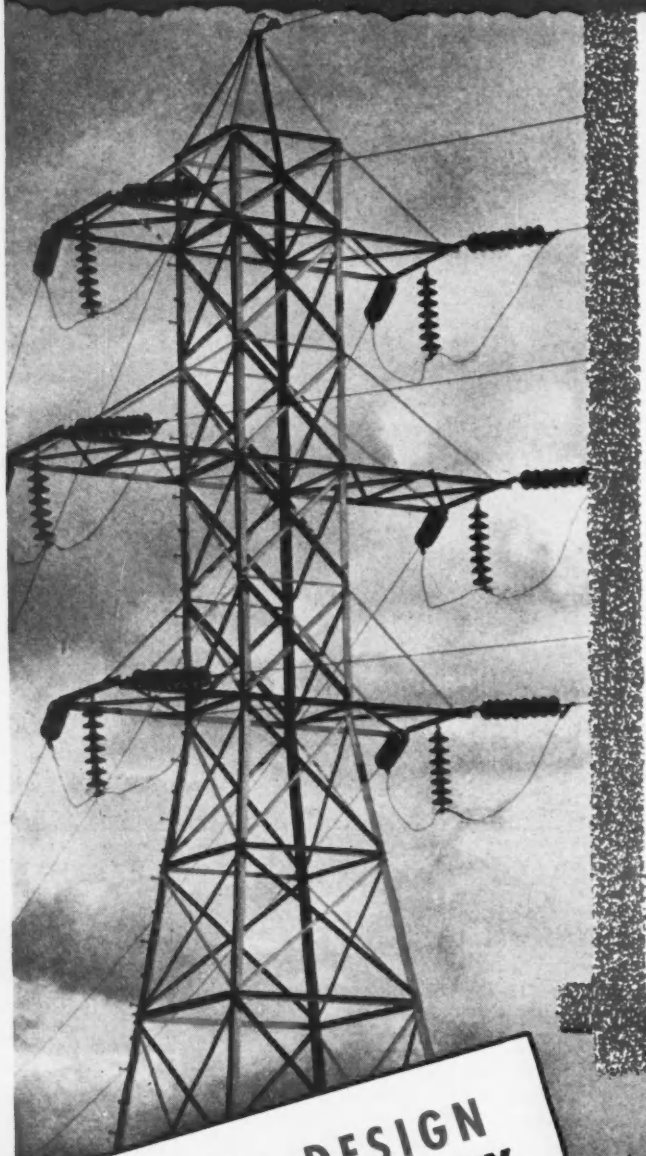
But condensers can do more than just cut conductor requirements. They also provide voltage regulation on a wholesale scale, and furnish rotating inertia for improved system stability.

Custom-engineered to fill system requirements and to fit installation conditions, Allis-Chalmers synchronous condensers can help you hold down transmission costs. For more information on units for utility or industrial applications, call in your A-C representative, or write for Bulletin 05B7285. Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3960

ALLIS-CHALMERS

MORE POWER



ANDERSON

Cast Aluminum

SUSPENSION and STRAIN CLAMPS

for

ALUMINUM TRANSMISSION LINES

Anderson cast aluminum electrical products have been designed, engineered and manufactured to a "formula" laid down by *the most exhaustive tests ever devised* for power line equipment. Their superiority sets a standard of quality and performance that is unsurpassed for rugged dependability.

ABW DESIGN MEANS QUALITY *plus* STRENGTH in the RIGHT PLACES

Guaranteed to withstand extreme loading, sudden shock and stress reversals far in excess of rated capacities.

Every safety factor has been engineered into Anderson Cast Aluminum Electrical Products . . . to insure uninterrupted power service *plus* lowered maintenance time and costs.

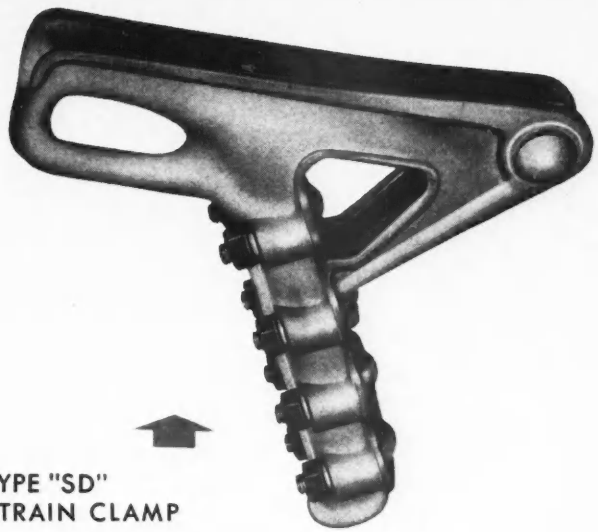
DELIVERED WITH *less* MAINTENANCE

They STOP hysteresis and eddy current power losses.

They PREVENT corrosion, heating and annealing damage to cables within the clamps.

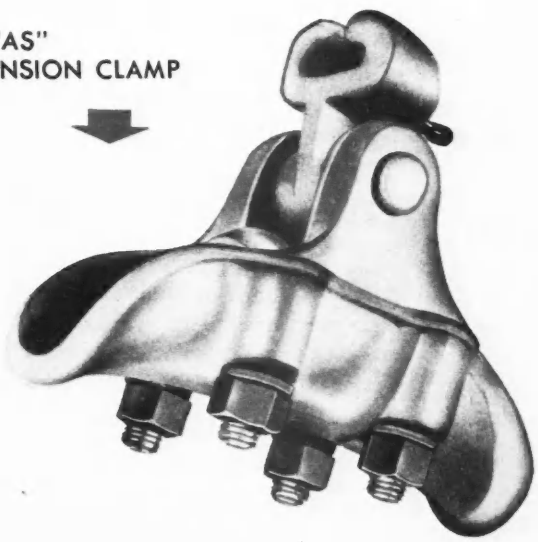
They ELIMINATE jumper splice failures . . . use through cable strain clamps with continuous jumpers at strain points.

BE SURE... SPECIFY... cast aluminum clamps that will guarantee you more than 25% greater strength.



TYPE "SD"
STRAIN CLAMP

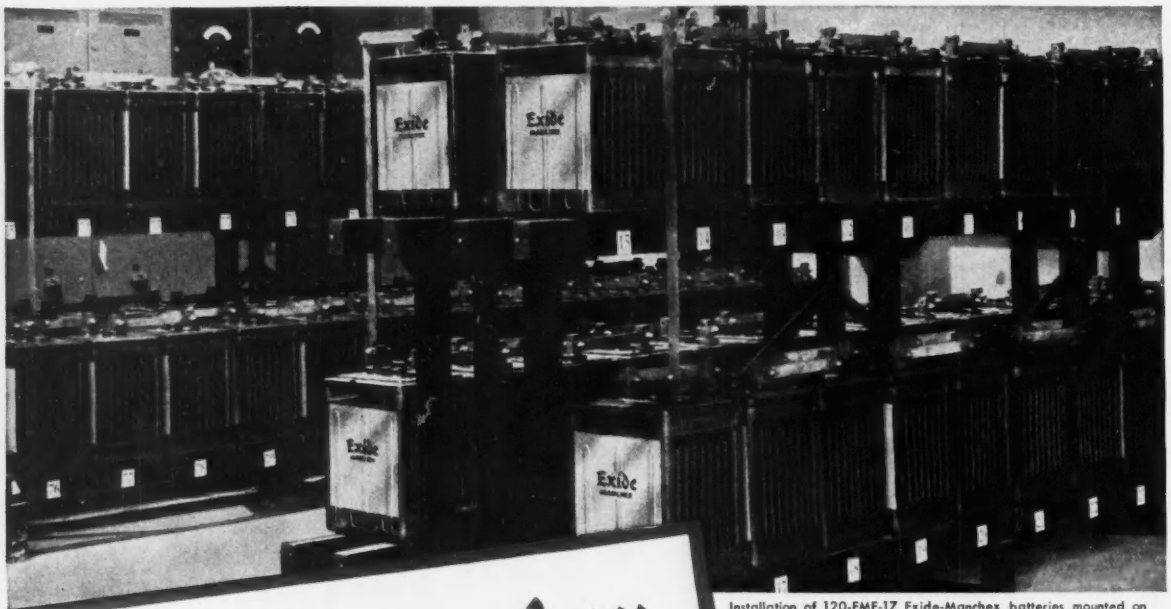
TYPE "AS"
SUSPENSION CLAMP



Write for recently published article, "Economy of Aluminum Suspension and Strain Clamps" . . . consult one of our nearest 20 representatives or write, wire or telephone our home office.

Aluminum & Bronze POWER CONNECTORS • CLAMPS • FITTINGS • ACCESSORIES
for SUBSTATION • TRANSMISSION • DISTRIBUTION

ANDERSON BRASS WORKS, INC.
P. O. DRAWER 2151 • BIRMINGHAM 1, ALABAMA



Installation of 120-EME-17 Exide-Manchex batteries mounted on two-level rack at the Duke Power Company, Dan River plant.

Exide-Manchex BATTERIES

FOR DEPENDABLE CONTROL POWER

Outdoor circuit breaker installation at Dan River plant.

The Duke Power Company built a new large steam-electric generating plant near Leaksville, North Carolina, the Dan River plant. This plant uses Exide-Manchex batteries. They assure:

POSITIVE OPERATION: Dependable performance at ample voltage for operation of switchgear.

INSTANTANEOUS POWER: High rates for switchgear operation with adequate reserve power for all other control circuits and for emergency lighting.

LOW OPERATING COST: Extremely low internal resistance.

LOW MAINTENANCE COSTS: Water required about twice a year. No change of chemical solution during life of battery.

LOW DEPRECIATION: Sturdy, long-life construction.

GREATER CAPACITY in a given amount of space avoids overcrowding.

• • •

Various sizes and types of Exide Batteries are available in plastic containers.

Exide-Manchex is your best battery buy for all control and substation services.

1888 . . . DEPENDABLE BATTERIES FOR 65 YEARS . . . 1953

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 2 • *Exide Batteries of Canada, Limited, Toronto*

"EXIDE" and "MANCHEX" *Reg. T.M. U.S. Pat. Off.*

with all sizes...
all grades...and...all finishes--

Castle

supplies all types of

COLD FINISHED BARS

to meet exact customer requirements
--from one of the most complete
stocks in the U.S.A.

Hats off to Johnson Motors--the only manufacturer who has built a million outboard motors! It takes a truly superior product...with a long record for superior performance...to earn the buying confidence--that enables it to top the million mark in sales. A. M. Castle & Co. is indeed proud of its long association with Johnson Motors...and...to have supplied all types of cold finished bars used in the production of this outstanding product.

Castle Has--EVERYTHING In Cold Finished Bars

The heavy continuous demand for cold finished bars of all grades, all shapes, and all finishes requires a large, extensive stock--ready to deliver. A. M. Castle & Co. has such a stock. Thus, Castle can give you quick delivery on rounds, flats, squares, hexes--in a great variety of sizes, grades, and finishes--in any quantity, large or small.

And when you order from Castle--you'll get exactly what you want...plus...fast, friendly, intelligent service on every order. That's been a Castle tradition for over 61 years. And that is one of the main reasons why A. M. Castle & Co. is one of the largest independent steel distributors in the United States--with nine large, heavily stocked, fully equipped warehouses from coast to coast. For cold finished bars...and...EVERYTHING else in steel --phone A. M. Castle & Co.

CASTLE
STEEL DISTRIBUTORS

EVERYTHING IN STEEL
COLD FINISHED BARS · STAINLESS STEELS
HOT ROLLED BARS · TOOL STEELS · ALLOY STEELS
SHEETS · PLATES · STRUCTURAL and many others
in a large variety of sizes, grades, and finishes--for immediate delivery.
from coast to coast

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STEEL DISTRIBUTORS

BALTIMORE · CHICAGO · MILWAUKEE · ROCKFORD · KANSAS CITY · SEATTLE · SAN FRANCISCO · BERKELEY · LOS ANGELES

30 years unfailing and NO TRACE of

TIME-TESTED . . . PERFORMANCE-PROVED

Through 30 years of uninterrupted service, this multi-gap resistance type arrester has protected the lines of a large Southern power company. "Service-engineered" by ESM Co. for long-life dependability, its porcelain housing was ventilated.

Examination of the unretouched photos of the gap assembly show that ventilation kept the interior always dry and clean. All electrodes were still in perfect operating condition . . . no trace of gap corrosion.

For 17 years the same time-tested advantages of gap ventilation have eliminated all moisture trouble from Crystal Valve Ventilated Gap Arresters. Free access of air in and out of housing means no moisture can accumulate to corrode gap electrodes, cause arrester failure. Result: A practically 100% record of perfect protection on thousands of installations all over the world.

For positive protection on every line, get the time-tested performance-proved reliability of Crystal Valve Ventilated Gap Arresters.

Write today for illustrated folder with full details.

After 30 years, all electrodes are still smooth, clean and uncorroded by moisture.

Secret of 30 years' dependability lies in gap ventilation through this opening in lower cap. Same principle assures reliability of today's Crystal Valve Ventilated Gap Arrester.

protection...

GAP CORROSION!

CRYSTAL VALVE

Ventilated Gap

LIGHTNING ARRESTER

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PA.

Represented in Canada by Lyman Tube and Bearings, Ltd., Montreal and Toronto

ULTRA-SPEED GAP FOR FASTEST PROTECTION
VENT OPENINGS ELIMINATE CORROSION DUE TO MOISTURE
CRYSTALLITE GIVES MULTI-PATH DISTRIBUTION OF SURGE
ESM
Service Engineered by ELECTRIC SERVICE

AT

TRIANGLE

IT *Must* BE RIGHT!

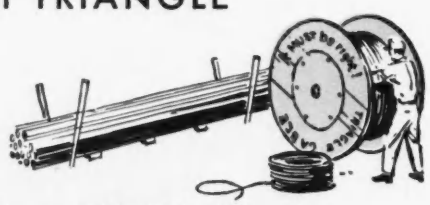
Walk into any one of Triangle's factories and the first thing to greet your eye is a sign: "It *Must* Be Right!" Then, walk between the long lines of whirling, pounding, busy machines. Every few feet you'll see those words — "It *Must* Be Right!"

That philosophy has been the order of the day at Triangle ever since the moment, back in 1916, when the wheels first began to turn. Everything at Triangle, from product through service, *must* be right.

Every day our customers benefit from this policy. Every day they get extras in quality and service they had not been able to get elsewhere.

Perhaps you too would benefit by doing business with a company who thoroughly understands its obligation to its customers.

You'll like doing business with TRIANGLE



The Trade Mark of TOP Quality

TRIANGLE

IT MUST BE RIGHT! ®

TRIANGLE CONDUIT & CABLE CO. Inc.

New Brunswick, New Jersey

When it's a Question of Carrying Electrical Power—Specify **TRIANGLE**

CADWELD®

. . . the best ELECTRICAL CONNECTION!

CADWELD SPLICE
OF 3,000 MCM CABLE

CROSS SECTION
CADWELD SPLICE
3,000 MCM CABLE

FOR any type connection, straight splice, Tee's, Y's, crosses, etc, of any size, #8 wire through 3000 MCM cable. Also bus, tubular bus or any electrical connection of copper to copper or copper to steel.

why?

1. Greater current carrying capacity than the cable itself.
2. Cannot loosen.
3. Cannot corrode.
4. Cannot burn up or melt out.
5. Able to withstand surge currents.
6. Every strand is welded into the solid copper mass.
7. Easy to insulate because of small outer dimensions.
8. Requires no outside source of power.
9. Made with portable equipment—excellent for field use.

Send Coupon for FREE
CADWELD ELECTRICAL
CONNECTION CATALOG

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☐ Send CADWELD ELECTRICAL CATALOG and place my name on permanent mailing list.
☐ Have Representative Call.

NAME_____ POSITION_____

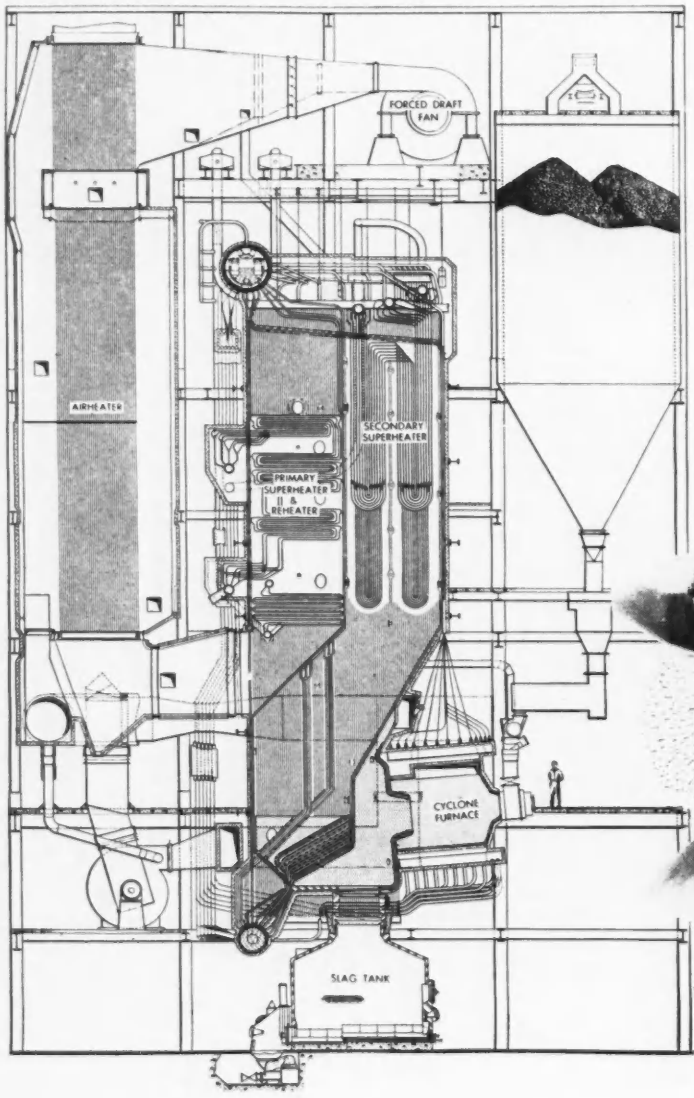
COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

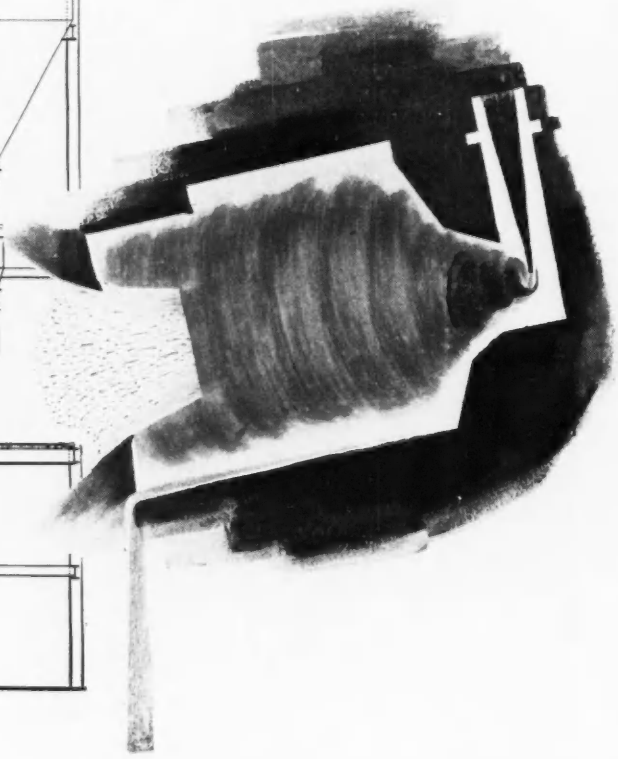
Another Cyclone-fired

HELPING TO PRODUCE LOW-COST KILOWATTS



B&W Cyclone-Furnace-Fired Radiant Boiler for E. H. Werner Station

This boiler supplies steam to drive a 62,500 kw, 3600 rpm tandem-compound reheat turbine, which operates with an initial steam pressure of 1650 psi and temperature of 1000 F, with reheat to 1000 F. The unit has a normal continuous steam-generating capacity of 475,000 pounds per hour, with a four-hour peak of 520,000 pounds per hour. The design pressure is 1875 psi.



installation

E. H. WERNER STATION

Jersey Central Power & Light Co.

Many outstanding design features are included in all phases of the new addition to Jersey Central Power & Light Company's E. H. Werner Station to achieve a net heat rate of less than 9400 Btu per kilowatt hour. The new B&W boiler, for example, incorporates many advanced developments to provide low first-cost, high efficiency, and economical maintenance. These include:

Cyclone-Furnace firing, with provision for burning coal or oil.
Compact Furnaces.
Low stack dust emission with no precipitators.
Pressure Firing, with elimination of induced-draft fan.
High Steam Pressure with Natural Circulation.
High superheated-steam temperature.
Reheated Steam.

While these engineering features have been used in various combinations on many boilers, the new unit at the E. H. Werner Station is the first in which they all have been co-ordinated to achieve maximum savings.

Jersey Central and its consulting engineers, Burns and Roe, Inc., chose Cyclone Furnaces as an economical way to reduce stack dust loading and prevent air pollution. Many other advantages were realized, including: Increased availability . . . Increased safety . . . Reduced maintenance . . . Simplified ash handling and disposal . . . Lower fuel costs . . . Wide load range.

Many B&W Cyclone-Furnace-fired boilers are in operation, in various parts of the country, burning many different kinds of coal. The operating requirements and the design conditions for these boilers include most of the variations that can be expected in utility practice. We will be pleased to discuss with you the many definite advantages which Cyclone-Furnace-firing can contribute to your operations. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, New York.

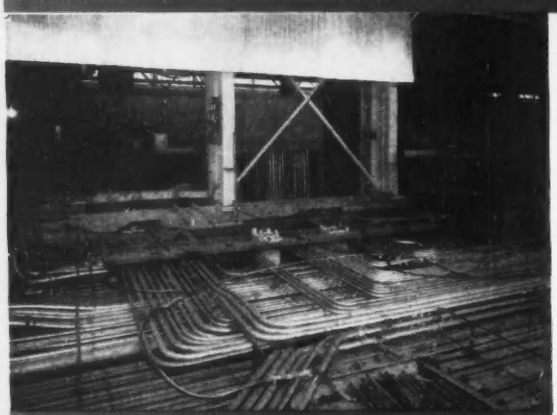
BABCOCK & WILCOX

BOILER DIVISION

G-613

in a Pittsburgh steel mill....

112 Tons of SPANG® Central Conduit



Today's modern steel plants use tremendous quantities of electric power to operate the many complex steel producing and processing machines needed to keep up with demand for steel products.

Installations of this type require conduit that . . .

—offers years of trouble-free service in a permanent installation.

—protects circuits in concrete-enclosed locations against pressure from concrete and corrosion from seepage.

—protects circuits in exposed interior locations against corrosion from atmospheric conditions, radical temperature changes and damage from contact with heavy equipment.

So, when Patterson-Emerson-Comstock, Inc., of Pittsburgh, specialists in steel mill construction, were called upon to build a new mill for a Pittsburgh steel manufacturer, they installed 112 tons of 1″ to 4″ Spang "Cenlaco" Conduit throughout the mill to handle the electrical circuits.

There were two reasons for specifying Spang:

1. SPANG CONDUIT IS QUALITY-CONTROLLED
Made from top-quality steel, Spang Central Conduit is carefully controlled under exacting conditions during forming and is thoroughly inspected to assure you of a reliable product with years of service life.

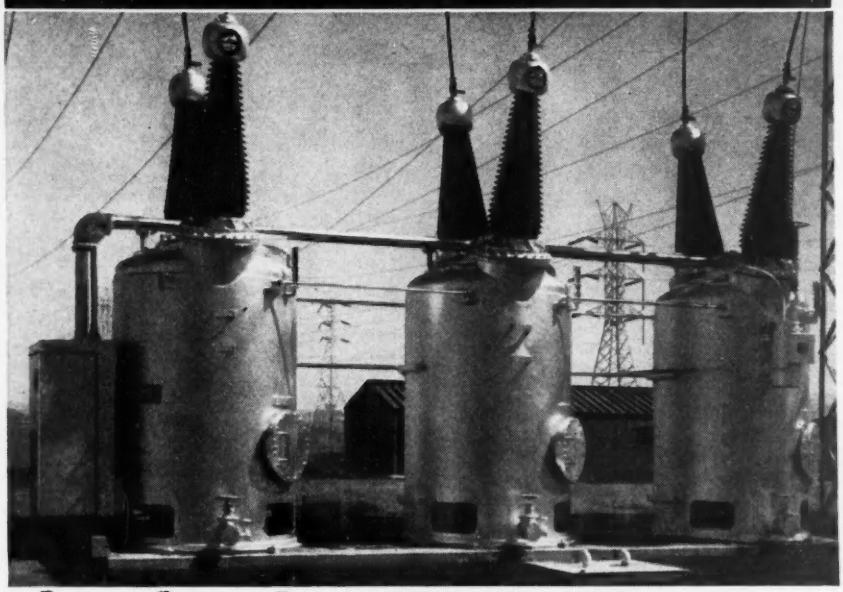
2. SPANG CONDUIT IS INSTALLED FASTER
Because of its quality-controlled manufacture, Spang Central Conduit offers such working advantages as easier bending, cutting and threading which saves time and money on installations.

You'll be sure of getting the finest conduit when you specify Spang. Take your choice of "Cenlaco," "Central White," "Central Black" or Spang EMT with the SPANGLEAM finish—all at your service.

SPANG CONDUIT

SPANG-CHALFANT
Division of The National Supply Company
GENERAL SALES OFFICE:
PITTSBURGH 30, PA.
District Offices and Sales Representatives in Principal Cities

Oil-Hydraulic Energy Transfer and Control of End-of-Stroke Conditions

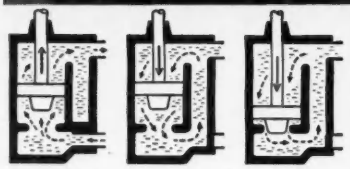


PACIFIC ELECTRIC Type RHE CIRCUIT BREAKERS

115 to 230 kv
3 cycle
to 10,000,000
interrupting kva
(at 161 or 230 kv)

Ground-mounted (as illustrated) or common-base mounted (115, 138, and 161 kv)

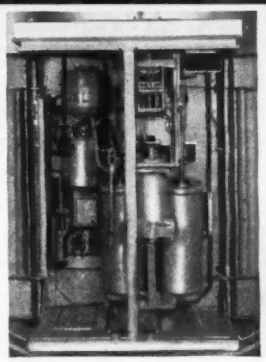
At left:
Type RHE 196/230 kv
3-cycle, 7,500,000 int. kva
10-cycle closing
20-cycle reclosing
(minimum 15 cycles if ordered)



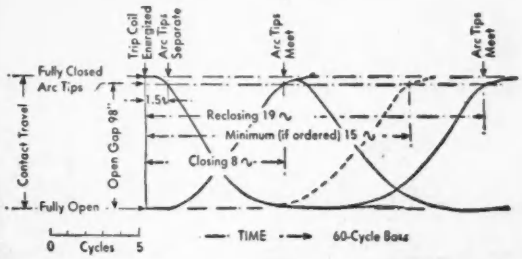
Multi-Use of Oil-Hydraulic Cylinder

UP STROKE	During DOWN STROKE	Toward end of DOWN STROKE
Energy transfer to closing springs	Energy transfer to opening springs	Orifice restriction absorbs shock

At right:
Operating Mechanism with Doors Open



Below: Contact-travel time chart showing open-close and close-open operations with oil in tanks



FAST Opening . . . Important? . . . Yes!

But equally important is stopping the mechanism so it comes to rest without undue shock or rebound. Also the breaker should *open fully* before reclosing to prevent impairment of insulation during the critical surge time that follows interruption caused by repetitive lightning.

How well Pacific Type RHE breakers perform in these respects is shown in the time-travel diagram at right.

Oil-hydraulic control of these end-of-stroke conditions is the reason why. The same oil-hydraulic cylinder and piston serves the dual purpose of (1) transferring closing energy to the closing springs on the up-stroke, and (2) decelerating the contact mechanism toward the end of the down stroke (see schematic diagrams at left).

OTHER FEATURES:

- Opening and closing springs and shock absorbers are outside of the tanks
- Nested Sliding Shoe (finger) Contacts
- Improved Interrupters
- Easy manual emergency operation for load switching as well as for test.

Since 1906

SALES OFFICES or AGENCIES in PRINCIPAL CITIES

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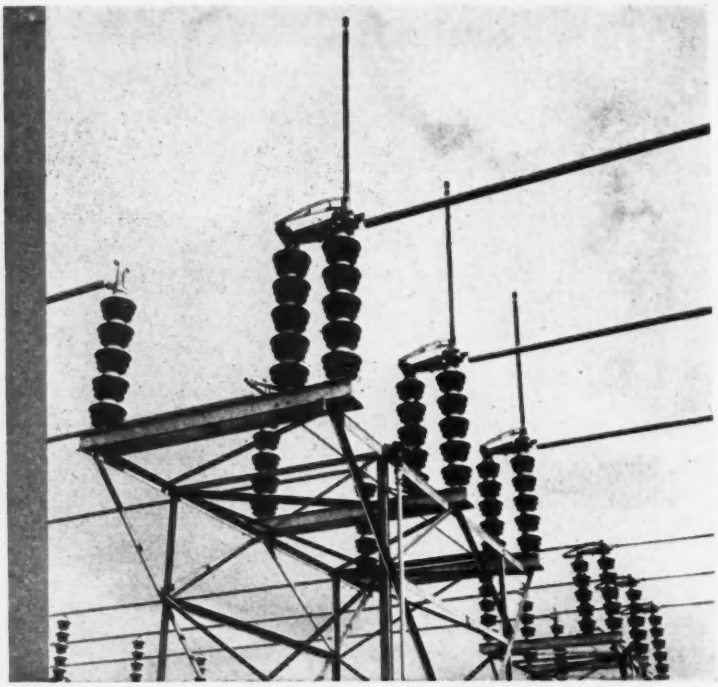
5815 THIRD STREET, SAN FRANCISCO 24, CALIFORNIA
OTHER FACTORIES: SANTA CLARA, CALIFORNIA; GARY, INDIANA

SCHWAGER-WOOD TYPE TA SWITCH

Here are two Schwager-Wood Switches —rated 230 KV—1200 amperes. The design of these switches incorporates the hinging of the blade over the rear insulator giving a substantial increase in the break distance. These switches conform to the highest standards and are available in all NEMA voltage and amperage ratings for outdoor air switches.



SCHWAGER-WOOD CORPORATION

High Voltage Switchgear • Substation Design, Equipment • Bus Fittings, Connectors **PORTLAND, OREGON**

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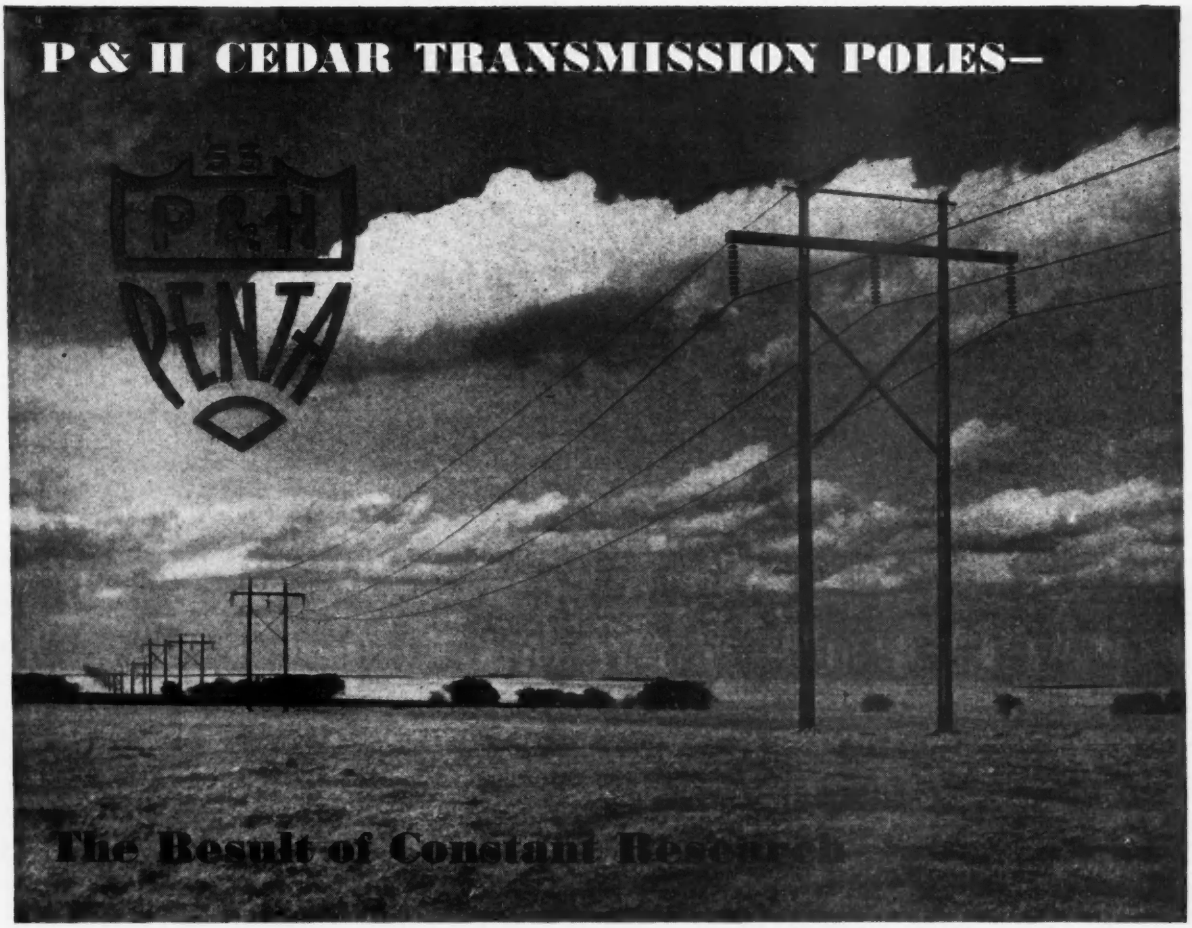
BUS FITTINGS AND CONNECTORS

SUBSTATION DESIGN AND EQUIPMENT



Transmission line between Omaha, Nebraska, and Midian, Kansas.

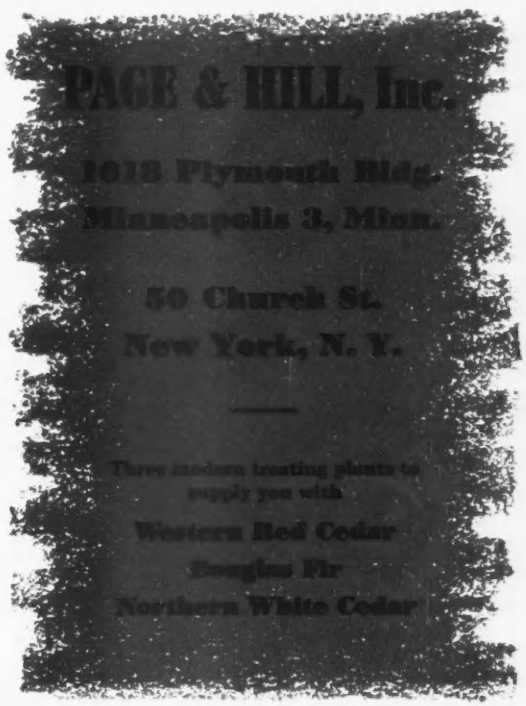
For more than fifty years, Page & Hill have consistently been improving the quality and service life of their poles through constant research in forest, laboratory and the users' field. First with incised butt treatment, then with guaranteed saturation of preservatives, it later followed with fifteen years of pioneer work in the development and application of Pentachlorophenol.

At every operation, constant research and laboratory control provide P & H Penta Poles with

1. **Maximum service life**
2. **Strength where needed**
3. **Proper bearing in all types of soil**
4. **Ease of handling**

In view of the high cost of labor and other installation expenses, it is more necessary than ever that the supporting structures for transmission lines remain secure. Western red cedar, inherently durable, assures this dependability when fortified with Penta.

The story of Page & Hill research with Penta is told in an attractive new brochure. Write for your copy today.

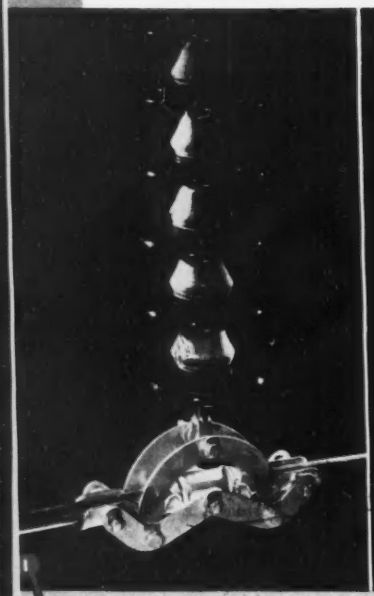


Let Locke be your partner in high voltage design –

"It pays," says Bob McCoy, citing case of Locke and American Gas & Electric Service Corporation

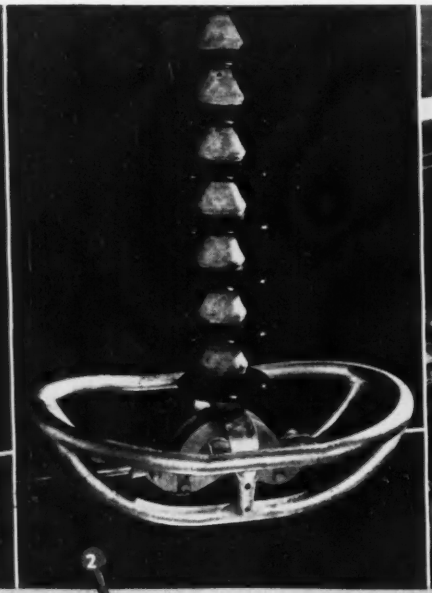
ROBERT L. "BOB" McCOY

If you haven't met Bob McCoy... chief product planner at Locke... you probably know about some of his achievements. Bob gets around, plenty, helping Locke customers lick all kinds of tough insulator problems. His 28-year experience came in mighty handy in this case of AG & ESC which Bob describes for you here. Bob's *our* man . . . but remember, when you've got a "toughie," he's *yours* for the asking!



1

New Suspension Clamp Developed — To support the large, hollow copper conductors used on the TIDD 500 kv experimental line, Locke designed and furnished a radically new articulated suspension clamp, much shorter and lighter than conventional clamps. Overall length of the new Locke clamp is 18 inches long, compared with the 32 inch overall length of a conventional clamp.



2

New Corona Shield Developed — To lick the corona problem on the TIDD 500 kv transmission line experiment Locke developed a new concept in corona shields. These shields graded the insulator strings and suppressed corona on the lower, highly stressed units. They also enveloped the suspension clamp, thus removing it from the high voltage field and suppressing corona on any part of the clamp itself.

3

Valuable New Data was revealed by extensive flashover tests conducted in the Fred M. Locke High Voltage Laboratory on varied suspension strings. These flashover tests were made with the insulators supported in a specially developed test rig to simulate true electrical conditions. As a result, important data was developed which helped establish the proper number of insulators to use per string.

When American Gas & Electric Service Corporation planned a new high voltage system, Locke was given an early opportunity to participate.

The first job was to cooperate in the company's Tidd 500 kv transmission research project. Pictures below show some of special products developed by Locke to help lick the big problem of corona suppression.

After the experimental Tidd tests, it was decided that 330 kv best suited the needs of the system. The problem was re-studied to reduce size and cost, and to make hot line maintenance work easier and safer.

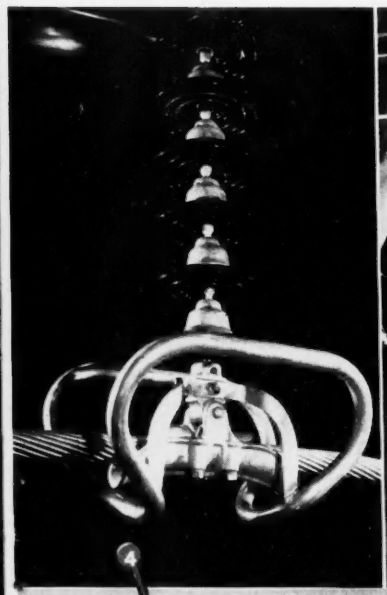
Here again the pictures show what Locke did to help overcome this problem.

"All of these 'service extras' in research and new product design are included in the regular price you pay for Locke insulators," points out Bob McCoy.

"Remember this case next time you're dealing with high voltage insulators and related fittings," says Bob. "You'll save time and money if you make Locke a member of your high voltage design team . . . right from the start!"

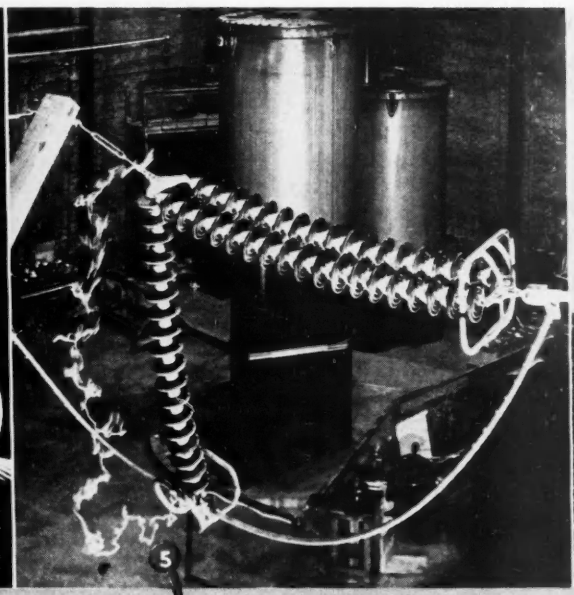
LOCKE

LOCKE DEPARTMENT
GENERAL ELECTRIC COMPANY
BALTIMORE, MARYLAND



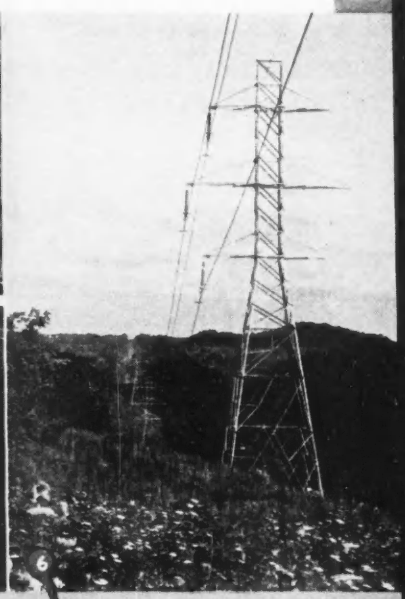
4

Hot Line Work Made Easier and Safer—At the conclusion of the TIDD tests, it was decided that 330 kv best suited the system's requirements. The entire problem was re-studied with an eye toward reducing size and cost and to make hot line maintenance easier and safer. The light weight, aluminum corona shields which can be removed and replaced on the suspension strings by removing only one self-locking nut was Locke's answer to the hot line maintenance problem.



5

Shield Removal Made Easier—In the case of the dead-end strings, Locke developed shields which can be removed and replaced by removing only two self-locking nuts. Instead of the shield being made in two halves, a one-piece shield was developed having an opening on the under side to clear the jumper loop. This one-piece shield was supported by two supports from the upper side with which bolts for attaching to the strain yoke were made integral.



6

Lines Now Operating—Today the first o these extra high voltage lines is in opera tion at 138 kv on the system of the Ap palachian Electric Power Company. Ha of this line is Locke equipped. Within th next few months this line is expected t be energized at 330 kv.

LOCKE welcomes unusual opportunitie like this to assist its customers.

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MOTOROLA 2-WAY RADIO

coordinates Duquesne Light Co. operations—gives instant push-button contact with 80 mobile crews.

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COMPARE THIS NEW METER SOCKET—*feature for feature*

More Wiring Space because (1) hubs are cast on *outside* of socket and (2) compact design of insulated mounting base.

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Reversible Jaws can be positioned for either vertical or horizontal mounting—in the field—without special tools.

5th and 6th Jaws can be easily added—in the field.

MEETS EEI and NEMA STANDARDS—Available with either 2 or 3 hubs, with or without back breakout. Also with one hub and threaded rear opening.

Another example of Square D's DESIGN LEADERSHIP

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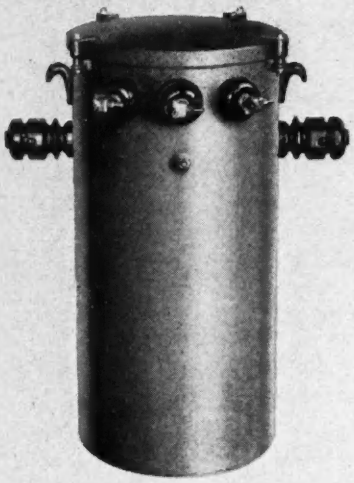
● If transformer failure keeps your linemen busy removing distribution transformers and installing new ones, then it's time to investigate Standard Transformers as a solution to your problem. Once a Standard Distribution Transformer is installed on a line, it's there to stay . . . silently channeling current to your customers.

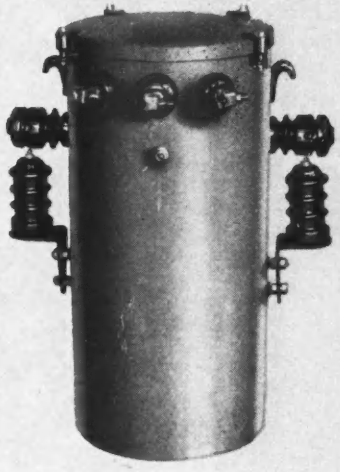
What makes Standard Distribution Transformers such dependable "watch dogs"? Close examination discloses sound, basic construction in full accordance with ASA and REA standards. Outstanding features set them apart from others as an indispensable and integral part of your distribution system. Covers are moisture-proofed with Neoprene gaskets which prevent oil leakage. They can be easily and quickly removed, allowing immediate access to vital parts. A rugged, copper-bearing steel tank houses the low-loss core assembly of non-aging, varnish-coated, silicon steel sheets. Specially designed core clamps hold core rigidly in place assuring quiet, trouble-free operation. These, plus numerous other construction features, demonstrate Standard Transformers to be helpful in solving your excessive maintenance problem.

Naturally, you want more information concerning Standard Distribution Transformers than that which we have presented in these limited words. Your nearby Standard Transformer representative has answers to your questions. Call him. Let him show you how Standard Distribution Transformers can help you maintain the excellent service your customers deserve.

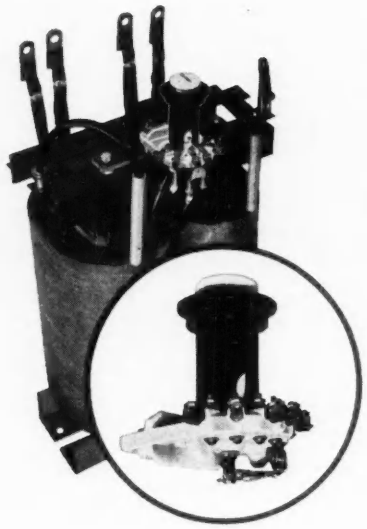


← Type A. OISC Conventional Distribution Transformer, 15 KVA, single phase, 60 cycle, with side wall mounted high voltage bushings. Standard construction for voltages 5 KV and sizes through 100 KVA.

→ Type CSP. OISC Distribution Transformer, 15 KVA, single phase, 60 cycle, with primary lightning arresters, internal fuses, low voltage circuit breaker and side wall mounted high voltage bushings. Standard construction for voltages 5 KV and less and sizes through 100 KVA.



TRANSFORMERS ARE A
YOUR DISTRIBUTION SYSTEM

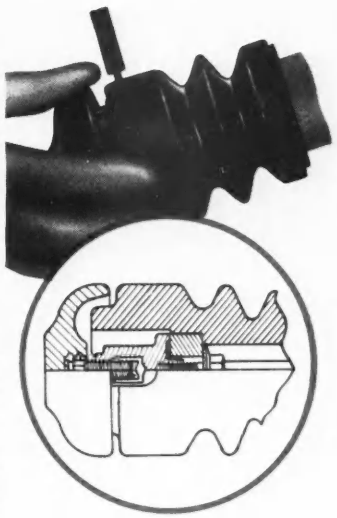


NEW TANK WALL BUSHINGS →

New bushings permit "flick-of-the-wrist" line insertion without tools. No live parts are exposed. Terminal compression stud keeps easy-to-grip, insulated porcelain cap from falling off when unscrewed to receive primary leads. Cables can be brought in from either side and held securely by pressure from the clamping shoe. Makes for faster, safer, easier installations.

← TAP CHANGER SWITCH

Standard's new Tap Changer Switch embodies a contact-making assembly with a brass wheel for positive contact. Normal settings are with 4-tap voltage section. 2½% taps within 10% range of normal rating. Standard supplies transformers with 4 taps above or below, or half above and half below as specified by the customer. This is available at no extra cost to you. Contact-making points are submerged in oil with the handle well above oil level.



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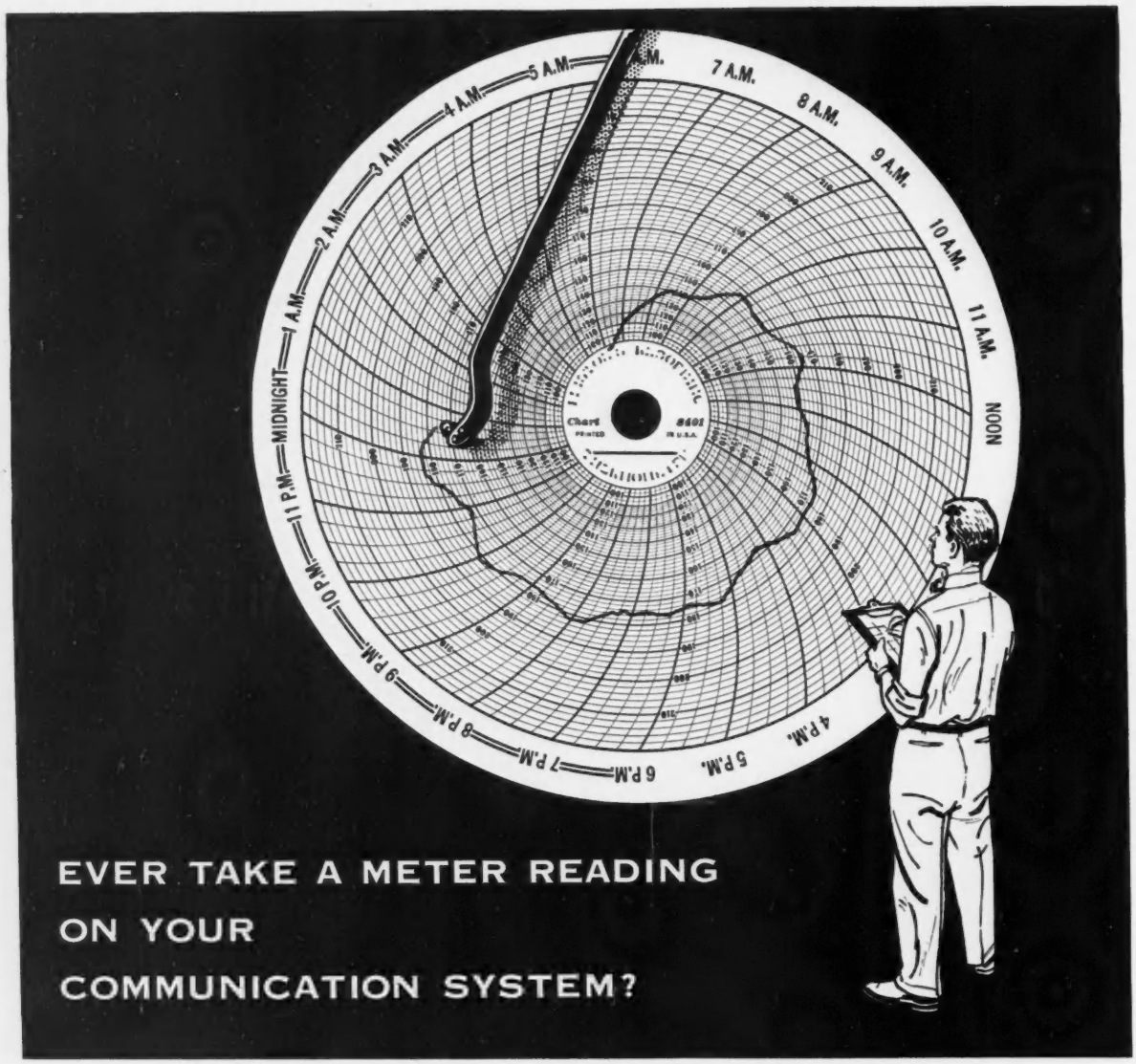

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Your Bell Telephone Company will make a comprehensive survey to help you get the best use of your facilities . . . local exchange, long distance, mobile, teletypewriter, metering and supervisory control . . . all the communications you use. More than one hundred studies are now underway for major pipe lines, power companies and railroads.

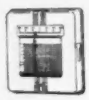
These surveys include recommendations to give your operation the best communications at the lowest possible costs. Many companies have changed, rearranged or added services on the basis of these surveys.

• If you are interested in a communication survey by Bell System experts without charge, call your local Bell Telephone representative now.

PRIVATE-LINE TELEPHONE

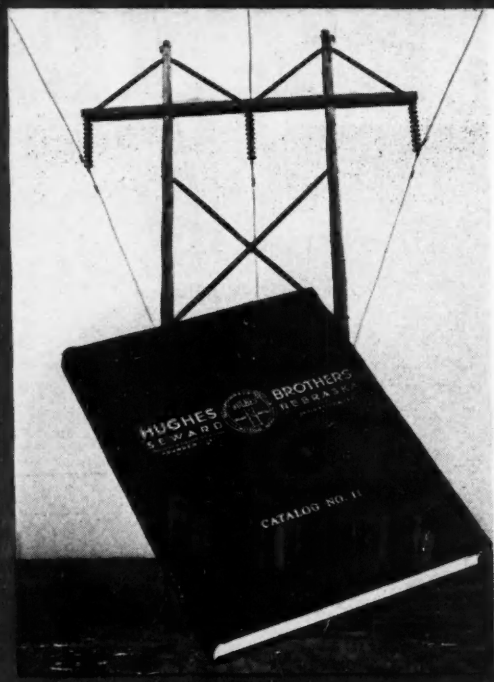
TELETYPEWRITER

MOBILE TELEPHONE



METERING CHANNELS

BELL TELEPHONE SYSTEM



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Hughes Brothers pioneered X-Brace construction, worked out the structural theory and confirmed it by full size tests.

THE ARMS . . .
Hughes Brothers lead in developing, testing and manufacturing factory assembled double arms.

THE KNEE BRACES . . .
Patterned after the X-Brace, another Hughes first for modern transmission structures.

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Many Hughes designs are widely accepted as standard construction.

Design Data are avilable for all voltages from 13.2 Kv. to 230 Kv.

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It's Tailored
TO YOUR NEEDS

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BROTHERS NEBRASKA
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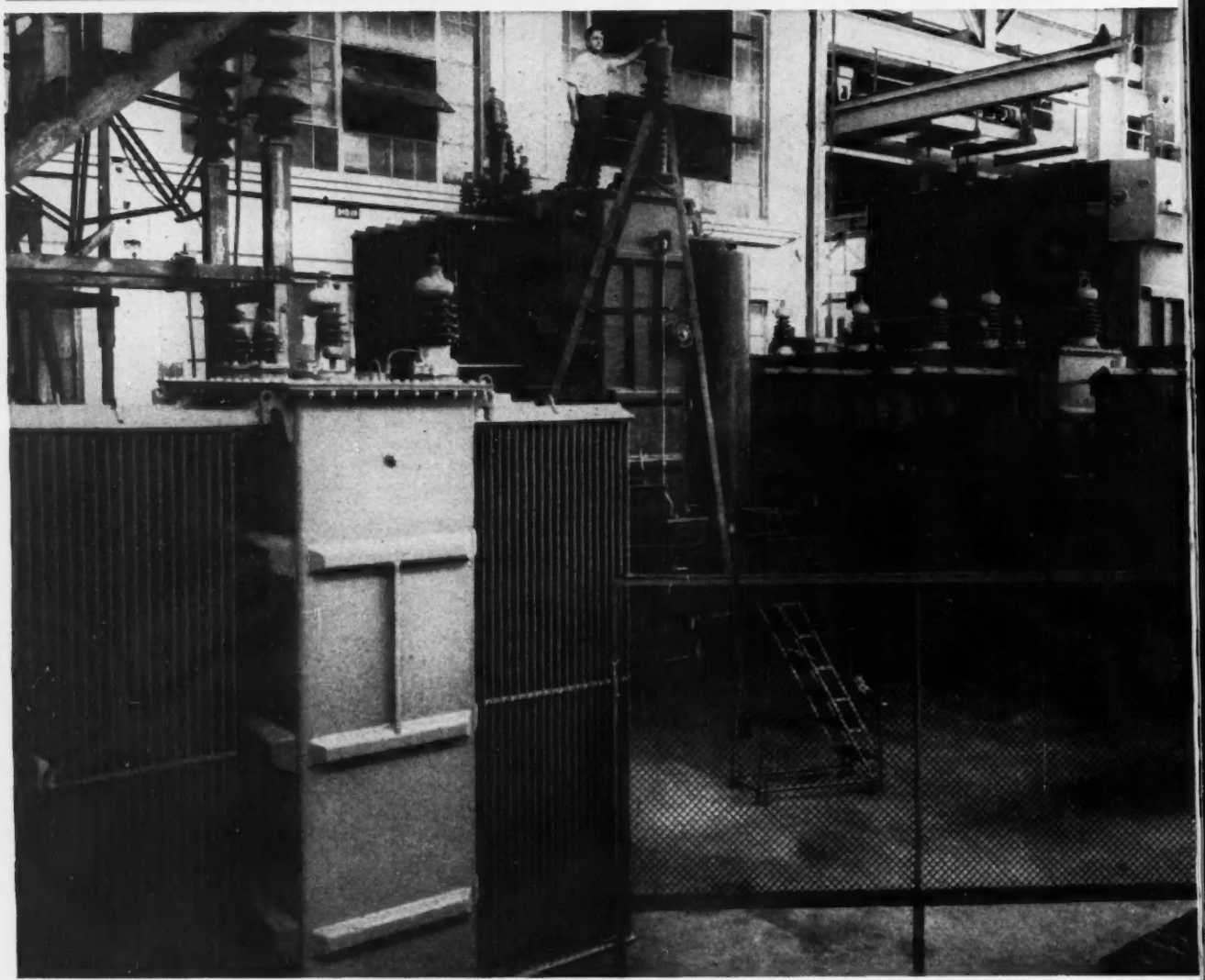
Wagner POWER



A typical group of Wagner Transformers nearing completion at the Wagner plant. Wagner has all the facilities necessary to manufacture power transformers up to 60,000 kva. Bulletins TU-180 and TU-181 give information on the complete Wagner Transformer line. Write for your copies.

Wagner Electric Corporation
EST. 1891

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AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

TRANSFORMERS

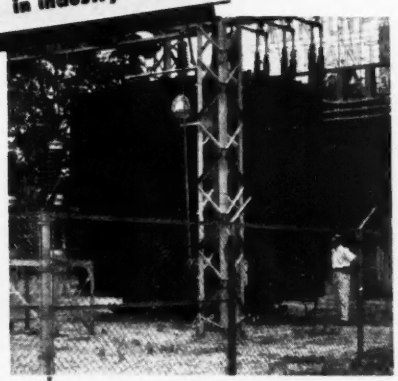
built to provide utmost reliability and service continuity . . .

Wagner has been building power transformers for more than sixty years. The knowledge gained and the facilities acquired in all those years make the building of fine power transformers part of the day's work at Wagner.

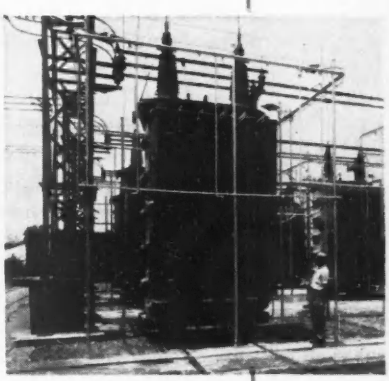
Years of engineering "know-how" —Wagner's insistence on the use of only the highest quality materials—carefully controlled production methods—rigid inspections and tests all combine to assure users power transformers that will provide utmost reliability and service continuity.

That's why you will find Wagner Power Transformers the first choice of a great many industrial and power companies. That's why it will pay you to consult Wagner on your next power transformer installation. Wagner maintains thirty-two branch offices, located in principal cities, for quick convenient engineering service and consultation.

Wagner
TRANSFORMERS
. . . the choice of leaders in industry



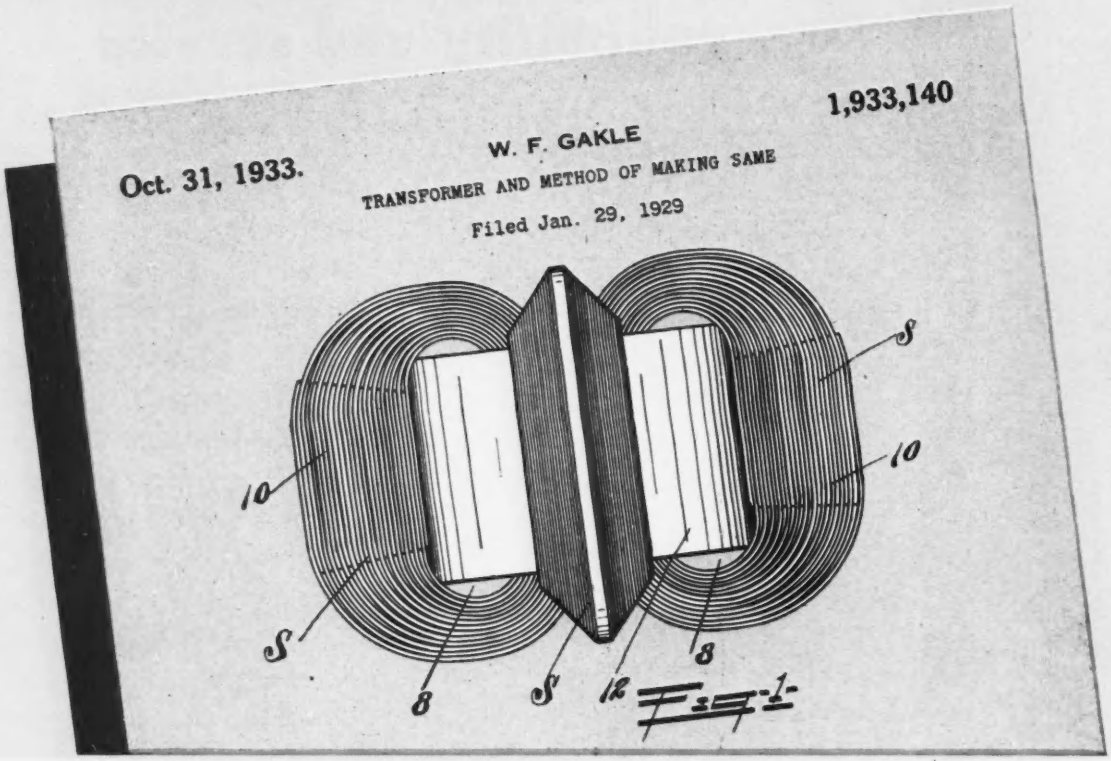
This Wagner Power Transformer, rated 20,000 / 25,000 / 33,000 kva, is installed in a midwest power plant.



One of ten oil-filled Wagner Power Transformers, each rated 5000 kva self-cooled, 6667 kva forced air-cooled, at a substation in New Orleans.

THIS IS THE 20TH

KUHLMAN Patent No. 1,933,140



Patent No. 1,933,140 was the first of the modern core designs.

Predating all other modern core forms, the Kuhlman Electric Company in 1929 applied for a patent on a radically different core design that improved the magnetic circuit and reduced substantially the weight of transformers. This was Patent No. 1,933,140—the original Bent Iron Core.

The patent was granted in 1933. For two years thereafter Kuhlman experimented further to make this core suitable for production. Then in 1935 the first Bent Iron Core transformer was put on the market. For the following three years it was the only core of its kind available to the electrical industry.

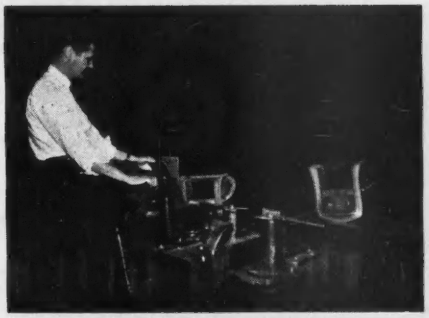
About 1938 cold-rolled, oriented grain, silicon steel was introduced to industry. Kuhlman engineers were quick to realize the advantages of the Bent Iron Core in fully utilizing the characteristics of this steel. Cold-rolled silicon steel provides a natural path for the magnetic flux in the core. This results in a reduction of exciting current by as much as 75%, and provides a further weight reduction. But, in order to obtain these advantages, it is necessary to construct the core in such a way that the magnetic flux can follow a continuous path parallel to the grain of the steel through a minimum number of air gaps.

This was no problem for Kuhlman. The Bent Iron Core had been constructed in just that way for the previous five years. There can be no doubt, then, that the Bent Iron Core—patented in 1933—20 years ago—is the forerunner of all magnetic improvements in modern transformers.

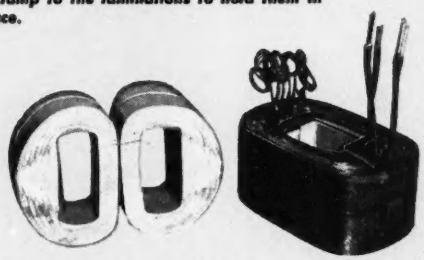
ANNIVERSARY OF

HERE'S HOW IT'S MADE

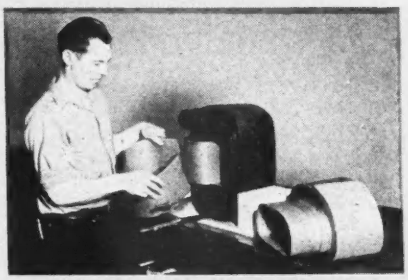
First, the laminations are cut to size and stacked. The operator clamps the stacks onto a hydraulic folding machine which bends them over a form into a U-shape. Before removing the pressure, the operator applies a clamp to the laminations to hold them in place.



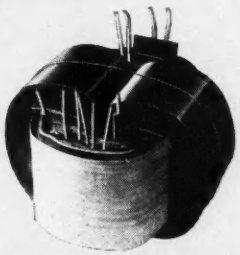
Another operator completes the bending by overlapping each alternate lamination. Levers on each side of the vise hold down each lamination as it is folded into place. The inner laminations have been cut shorter so that the outer ones will overlap.



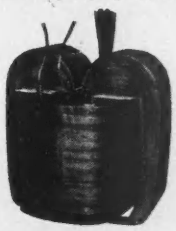
After the cores have been bent they are bound with wire and annealed to relieve the stresses caused by bending. Here are two annealed Bent Iron Cores next to the coil to which they will be assembled.



The assembler has disassembled a core and is now filling the coil lamination by lamination. The laminations retain their shape because they have been annealed. As soon as he has assembled a core to the other side of the coil, he will bind the whole assembly tightly together.



Here is a completed Bent Iron Core and coil assembly. The four air gaps of the old butt type core have been reduced to two, and the magnetic flux will always flow parallel to the grain of steel, never crossing it.

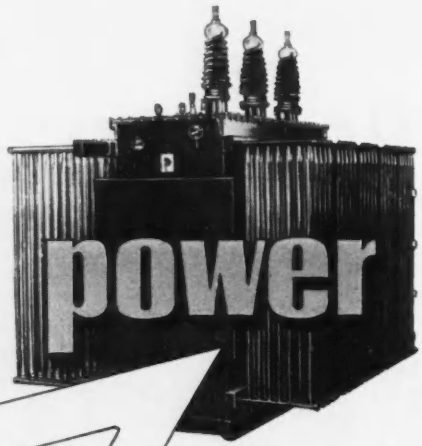


This is a recent variation of the Bent Iron Core, known as the BIE. Notice that the laps are at the top rather than at the sides. This allows for the manufacture of Bent Iron Core transformers of higher KVA rating without increasing the overall size of the transformer.

Kuhlman **ELECTRIC COMPANY, BAY CITY, MICHIGAN**
CRYSTAL SPRINGS, MISSISSIPPI

EXPORT REPRESENTATIVES: *International Standard Electric Corporation,*
50 Church Street, 15th Floor, New York 4, New York. Cable Address: Microphone, N.Y.

Uptegraff power Transformers



Long Life and Low Maintenance assured by important features of ***Design and Construction***

RUGGED

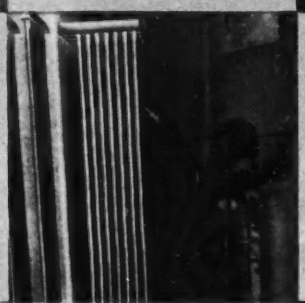
Special tank bracing withstands pressures of ±10 psi for ratings of 44 KV and less, and ±15 psi for higher ratings. Radiators are sturdy, yet accessible for cleaning and painting.

TIGHT

To eliminate leaks in sealed joints, a modern supersensitive electronic leak detector is used. It will find leaks as small as one ounce of air per year!

UNDERCOATED

The under surfaces of all Uptegraff Power Transformers are treated with a heavy coating that protects inaccessible areas against corrosion.

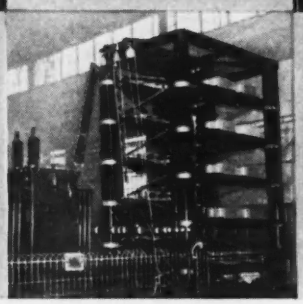


SHOT BLASTED

Tanks are thoroughly cleaned by shot blasting to prepare surface before protective paint coats are applied.

TESTED

Every Uptegraff Power Transformer is thoroughly tested before shipment. Modern test equipment includes a 1.5-million volt surge generator. We are fully qualified and equipped to make all NEMA, AIEE, ASA and other tests up to 10,000 KVA.



ALL SIZES

Made in sizes to 10,000 KVA, 115 KV for indoor or outdoor service. Oil or askarel filled. Uptegraff transformers meet the standards of ASA, NEMA and AIEE, and are *fully guaranteed.*

R. E. Uptegraff Manufacturing Co.

Scottdale, Pa.

Transmission Towers by AMERICAN BRIDGE handle nation's first 330,000-volt line

● The first leg of the American Gas and Electric Service Corporation's projected high voltage transmission network has been completed with the construction of a 63-mi. 330,000-volt, double circuit link running from Appalachian Electric Power Company's Kanawha River, W. Va., station to its Philip Sporn plant.

The towers for this record-setting line were designed and fabricated by American Bridge as the result of valuable data gathered from the A. G. & E. sponsored 500,000-volt test line at Ohio Power Company's Tidd plant, Brilliant, Ohio, in cooperation with other manufacturers of high voltage transmission line equipment.

These towers are approximately 150 feet tall and carry 6 conductors of 1,275,000 C.M., A.C.S.R. expanded cable (1.6"OD). The towers are designed for straight-line spans of 1700 ft.

The technical knowledge and field experience American Bridge has acquired in this and hundreds of other transmission line installations may be just the answer to your tower problems. Our engineers welcome an opportunity to figure with you without obligation. Just write to the nearest office listed below.

AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.
Contracting Offices in: AMBRIDGE • ATLANTA • BALTIMORE • BIRMINGHAM • BOSTON
CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • DULUTH • ELMIRA
GARY • MEMPHIS • MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH
PORTLAND, ORE. • ROANOKE • ST. LOUIS • SAN FRANCISCO • TRENTON
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

DESIGN REDUCES FOUNDATION INSTALLATION COSTS. Important savings in time, labor, and materials were made possible through use of steel grillage earth anchors and variable leg extensions as shown above. Many other simplified installation and frill-free construction features are obtained through American Bridge designs.

USS TRADE MARK

AMERICAN BRIDGE

UNITED STATES STEEL

Moloney Completes Line of Regulating Equipment

DEPENDABLE service is the key word in the operating and public relations pictures of today's utilities. Every piece of equipment is important in your system if your customers are to enjoy continuous power at constant voltages. And dependable service is actually a matter of dependable equipment . . . equipment with a margin of safety that protects your customers . . . equipment that helps you retain their "good will."

Now, you can get Moloney Electric quality in pole type step voltage regulators as Moloney completes its line of regulating equipment which includes Step Voltage Regulators, Regulating Transformers, and Load Ratio Control Equipment on Power Transformers.

All the "extra values" that are the mark of Moloney equipment can be found in these new pole type regulators. More design, more craftsmanship, the finest materials provide an even wider margin of safety—so important in today's operating picture.

Taking advantage of their recent entrance into the Pole Type Regulator field, Moloney engineers have been able to incorporate into their regulator, the features which operating groups have found desirable. These new Moloney Pole Type Step Voltage Regulators are built to meet your present—and future—needs.

The units are available in all standard voltage and current ratings. They provide a plus or minus 10% voltage regulation in 32 equal ⅝% steps of rated voltage. Since they are self-contained and automatic, they are ideally suited for remote locations . . . rural feeders and lightly loaded urban lines.

Moloney has kept quality high and size and weight at a minimum. By using the famous Moloney HiperCore wound core design, a light weight, compact, more efficient core-and-coil assembly is achieved. This core-and-coil unit together with switching reactor, current transformer, and switching mechanism is of unit type construction for ease of inspection and handling.

Most parts of the switch mechanism incorporate the same operating principle as the performance proven Load Tap Changing equipment as supplied on large Moloney Voltage Regulators and Transformers. The motor driven switching mechanism operates through a Geneva gear, spring accelerator-decelerator type transmission to provide a dependable sharp snap action to current interrupting contacts.

The control cabinet can be removed from the tank wall for easy access mounting at the pole base. Complete automatic and optional manual control is provided. Adjustment and voltage level rheostats permit installation and calibration of the regulator with system voltage as the regulator is installed without incorporating an external power supply. The control instruments and equipment are mounted on a single removable panel for service shop maintenance inspections.

Consider the many "years ahead" features of these fine, new Moloney Pole Type Voltage Regulators . . . consider the reputation of Moloney products for long service and dependability . . . consider everything and you'll make it *Moloney all along the line.*

MEB3-31

MOLONEY

ELECTRIC COMPANY

Manufacturers of Power Transformers • Distribution Transformers • Load Ratio Control Transformers • Step Voltage Regulators • Unit Substations

FACTORIES AT ST. LOUIS 20, MISSOURI AND TORONTO, ONTARIO, CANADA • SALES OFFICES IN ALL PRINCIPAL CITIES

Current Transmission Practice

The reader may well be one of those who has asked why Electrical World has not made recently a survey of transmission lines like those presented "a few years ago." Time slips by fast. Those surveys were made in 1927 and 1929—practically 25 years ago. But there was little point in conducting a survey of lines in the early thirties (the lean years). And the intensive studies of lightning during the ensuing decade made it desirable to await their results.

But now the chorus of requests has been answered. In this issue Electrical World presents the significant technical details of 281 transmission lines of 100 kv and up. Whenever anyone now desires to know the trend of practice as to structures, insulation, conductors, clearances, or grounding, he can refer to these design samples as an authoritative index of practice. Validity is vouchsafed by the fact that they embrace the whole country and are confined essentially to lines designed or built in the past decade. In this way they reflect the application of the lessons learned during the industry's intensive study of lightning itself and the counter-measures effective in controlling it. Those who saved copies of the 1927 and 1929 compilations (long out of print) can compare design of the two eras and sense why modern practices have so greatly improved the non-outage performance.

Collecting, collating, tabulating, and interpreting the voluminous mass of information was no casual task. It took more, far more, editor-hours than were envisaged when the operation was undertaken. There are, however, no regrets. Electrical World cherishes the confidence imposed by its readers in the tacit promise that when statistical-technical round-ups are desired, its editors will undertake them.

Whenever such a compilation is made, there is usually the double-edged fear that either or both of two things may happen. First, some well-meaning but inexperienced engineer may use the average values of the tables as a direct guide for design of a new line. No such tabulation is safely a blind, formalized guide to follow in short-circuiting any sizable part of the design analysis for a new line.

The second is the temptation for editors to interpret the data in broad-brush generalizations. Our editors disdain to transgress in this respect. They have merely lifted out significant items for re-presentation in separate tables to show trend values.

Data in the transmission survey are comprehensive, they are authentic, and they are significant. They cannot be found anywhere else in comparable form. They constitute at the very least a basis for checking proposed designs of transmission lines to determine whether, all factors considered, the details are in line with a cross-section of established practice.

Let's Change the Rules

The great game of politics is remarkable for one thing—the number of times the rules are changed. Since the time of Caesar political parties and interest groups have tried to change the rules in their favor. This is the principle behind such moves as Roosevelt's attempt to pack the Supreme Court, the frequent gerrymandering of political subdivisions, and the fight to eliminate the filibuster as a Senate weapon.

Since the mid-thirties the Federal Power Commission has been one of the strongest regulatory bodies controlling the electric utility industry. The Democrats gave it extensive powers. Apparently they were satisfied with it as it cracked down on the private companies. But the FPC is a quasi-judicial body. It makes its rulings according to its own interpretations of the laws involved. Its decisions are subject to the nation's courts. Recently in more and more cases the FPC has been finding that the private companies have been on the right side of the law. The courts have been supporting these decisions.

Such conditions are intolerable to the federal power proponents. Naturally the thing to do is to change the rules. In the closing days of the 83rd Congress a group of 17 senators favoring federal power introduced a bill to give Congress veto power over licenses issued by the FPC. The veto would be applicable to any license issued where the proposed project deviates from a federally drawn basin development plan. And most of the 17 senators are Democrats. They want the rules changed. And if that isn't politics, what is?

Get That Shore Site Now

Population density of the U. S. A. on an area basis is about 55 inhabitants per square mile. A new sort of population density seems to be acquiring significance. This is shore-line density. If all 165,000,000 Americans decided to go to the 16,500,000 (plus or minus) ft of Atlantic, Pacific, and Gulf shore line, the density would be 10 per ft—10 deep waiting for the plunge or the sail. Cities are mindful of congestion; so one by one they are buying shore frontage to convert into recreation parks.

Stamford, Conn., is about to do this or at least the courts have granted the city condemnation rights for acquisition. The ominous fact is that the land the city is seeking is that purchased by the Connecticut Light & Power Co for a power plant site. But proceedings in the zoning board went adverse to the company. Now the city decides it wants the land and is apparently on its way to exercise its prior right.

At this stage it is not clear what a power company can do to establish its own brand of public need and convenience for power plant purposes when it assembles and pre-tests a plot peculiarly appropriate for the purpose. Civic convenience and necessity, even if only for recreation purposes, seems to take precedence.

In the some 3,000 or so miles of our total usable coast line there are comparatively few spots that offer a group of advantages for a power site.—deep channel, ample condensing supply, rail connection, transmission get-away, good foundation, etc. Some of these points are likely to be adjuncts of a beach area that the nearby community might contemplate with a longing eye.

It looks, therefore, as if early moves should be made in some areas to acquire plant sites, lest the preliminaries and official sanctions prompt the civic leaders to earmark those feasible sites as public playgrounds on an assertion of a health-need.

The Engineers Take Over

The appointment of Wilbur A. Dexheimer as Commissioner of Reclamation is certain to be followed by significant changes in bureau policies. As Dexheimer said soon after he succeeded Michael W. Straus, "Engineers are now going to run the bureau."

Despite the fact that the bureau is one of the federal government's biggest construction agencies, Straus, its boss for some seven years, was a newspaperman. He had a flair for publicizing the bureau; but when it came to engineering details and policy, he had to rely on his subordinates. Dexheimer, on the other hand, is a veteran bureau employee. His last job was assistant chief of construction in the bureau's Denver headquarters. He is at home with blueprints and slide rule. And because he has had considerable field experience, he can understand the many difficulties that arise in constructing huge power projects. No doubt he will also be able to draw on his broad experience to minimize or solve them.

A similar change has also taken place in the bureau's California office. There Clyde H. Spencer, who has been construction engineer at Hungry Horse Dam, has replaced non-engineer Richard L. Boke.

The industry will welcome these two changes. If the federal government is to continue spending millions of dollars annually for power, irrigation, flood control, and other projects, the money should be spent to best advantage. With practical, level-headed engineers in control of the activities of the Bureau of Reclamation the nation's taxpayers will have fewer worries on the way their money is being spent.

Water Systems Sell Appliances

For every pressure water system sold to a farm or other rural service customer, the dealer also sells an average of 2.7143 other electrical appliances that require, or are associated with, the availability of running water. That's pretty exact figuring, out to the fourth decimal. And it may be right, or nearly so.

But whether or not 2.7143 is exactly right or only an approximation is not important. What is important is the fact that purchase of a water system makes the buyer an interested prospect for the sale of a water heater, an automatic washer, a dryer, and other appliances. This is something for the dealer to remember and the electric utility, too.

Speaking of remembering, we must not forget to tell where that 2.7143 came from. Ed Smith, who heads up rural service for the Dayton Power & Light Co, reported that dealers in his company's area sold 399 water systems last May, which was "National Water Systems Month". And the same dealers in the same month also sold 1,083 electrical appliances that require running water for their operation. Dividing 399 into 1,083 gives 2.7143.

THE ELECTRICAL WEEK

The Issue's News Highlights—Republican Administration has taken the lid off its long-range federal power policy, in a statement made by President Eisenhower and Interior Department aides.

"An active Communist cell" has reportedly been uncovered in San Francisco area public utilities. Pacific Gas & Electric dismisses five as "poor security risks."

Five-man investigating team is looking into operations of Bureau of Reclamation, preparatory to making recommendations for reshuffling agency.

Kentucky Utilities, Louisville G&E, and Union Light, Heat & Power ask Franklin Circuit Court, Frankfort, Ky., to set aside Kentucky PSC order authorizing East Kentucky Rural Electric Co-operative Corp to build 400 additional miles of transmission lines to serve the co-ops $30 million steam plant now under construction at Ford in Clark County.

Tampa Electric buys land for new power plant for $107,125 . . . 362 Virginia E&P employees have successfully completed the company's two-year-old distribution transformer training program . . . Carolina P&L's "fire fighting campaign" in Tide Water area has already reached 93% of its 950 kw quota of commercial cooking installation. Prior to this campaign there was practically no electric commercial cooking in this area . . . South Carolina E&G lets building enlargement contract for third unit of 100,000 kw. First two units are 75,000-kw each.

Off the New England Wire—Celebrating the advent of its 100,000th customer, Hartford Electric Light presents Mr & Mrs Armand J. Loranger with an electric clothes dryer at their newly occupied ranch-type ranch. Company's first customer was put on the line in 1883 . . . Eastern Utilities Associates, serving southeastern Massachusetts through companies in Brockton-Pawtucket-Fall River area, report industrial energy sales exceeding the previous summer record for June.

Public Service of New Hampshire's allowed rate hike did not result in 5.65% return on rate base established by PSC as equitable in the past 12 months. Pres A. R. Schiller states that with such a low return it is inevitable that company will have to pay higher interest rates for new money, which must result in permanently increased costs of electricity to consumers. It will sell $7 million first mortgage bonds due 1983 shortly.

Dayton P&L adds 4,775 residential customers in first seven months of 1953 which is "greater than entire year of 1949 and the greatest annual increase in new customers in history of company," Pres Kenneth C. Long has announced.

Scranton Electric and UWUA-CIO are still continuing general contract negotiations. The 22¢-an-hour increase mentioned on this page on Aug. 17 refers to an adjustment under discussion for one job classification only.

Off the Washington Wire—Interior officials believe deal can be worked out for power exchange between SPA and Missouri G&T co-ops. This arrangement would replace the lease-purchase contracts between SPA and the co-ops which were ruled out by Congress. Negotiations on the substitute agreements were under way in Washington last week . . . Harvey Aluminum, Inc, is asking FPC for a preliminary permit for a proposed 1,475,000-hp hydro project on Copper River in Alaska.

Leslie Surginer, REA controller, is stepping out of the agency August 28 to take a job with the Army Audit Section . . . Bureau of Reclamation has signed 20-year contract to serve City of Rock Rapids, Iowa, with power from Missouri River basin hydro projects. Contract provides for 1,500 kw of firm capacity with an estimated annual consumption of 6,750,000 kwhrs.

First atom-powered electric "package" plant, patterned after the submarine propulsion unit being tested by AEC at Arco, Idaho, may go to the U. S. Army. These plants can be used at army installations where fuel is a problem. To run these plants it will probably cost 3¢ to 6¢ a kwhr but they can still compete with other fuels because of transportation costs.

Grays Harbor PUD buys 2.6 mile single-phase distribution line in Fords Prairie area from Puget Sound P&L for $8,400 . . . Ohio Edison buys 144-acre plot for $259,000 for a new service center in Fairlawn.

Arkansas-Missouri Power plans to sell $2 million bonds due 1983 . . . Atlantic City Electric proposes to sell around $15 million bonds preferred and common stocks early next year . . . Standard G&E will distribute to its commonholders of record Aug. 25 one common share of Duquesne Light for each four common shares of Standard held . . . Mexican L&P's Chairman George S. Messersmith says that the "very difficult cash problem" of past few months has made it necessary to slow down the expansion program.

Missouri P&L gets PSC approval to increase rates $445,000 a year, effective Aug. 16 . . . Kittery (Me.) Electric Light reduces rates for large-users by about $7,000 a year . . . British Columbia Power Commission reduces first block in all residential and commercial rates by 2¢ per kwhr in Quesnel, William Lake, and Terrace, B. C.

Congratulations—Middle West Service elects Vice Pres Edwin Vennard President to replace K. D. Carpenter, and Vice Pres R. McClanahan executive vice president . . . Carl J. Forsberg, Lake Geneva district manager for Wisconsin P&L, becomes utility's vice president in charge of operations . . . Charles A. Macfie is named president of Revere Copper & Brass, succeeding James M. Kennedy, who is elected board chairman and chief executive officer. Revere also elected Robert M. Lake vice president of the Rome Division.

The President says "I fully approve" as . . .

Chief tenets . . .

- **Primary responsibility for supplying power needs of an area to rest with the people locally.**
- **More reliance to be placed on non-federal bodies to furnish necessary transmission facilities.**
- **Preference customers to continue to have first call on purchase of federally produced power at the time it becomes available. Interior Department not to supply expanding demands of such customers.**
- **Privately owned utilities to get second call on federally produced power, putting them ahead of large industrial customers.**
- **Interior not to exercise control over resale rates on power sold to preference customers.**

GOP Changes the Course of Federal

The Republican Administration has unveiled its own federal power policy—marking a radical departure from the pro-public emphasis of the New and Fair Deals.

President Eisenhower publicly endorsed the Interior Department statement which charts a limited federal role in the development and marketing of electric power. "I fully approve of this policy," The President said.

The statement, billed as "a summary of the guiding principles which . . . Interior will hereafter follow," blocks out the specific policy areas of a federal power program.

Differences Summarized . . . Specifically it announces these departures from the power policy practiced during 20 years of Democratic reign:

- Interior agencies will no longer argue they have a utility responsibility in meeting the power needs of federal power areas.
- Interior no longer assumes that it has the sole responsibility for development of the nation's hydroelectric resources. It will not oppose development by non-federal agencies which are willing and able to provide comprehensive development.
- Interior will not shy away from construction of transmission lines needed to dispose of federally produced power, but it will rely more heavily upon non-federal bodies to furnish such lines.
- Public bodies and cooperatives will continue to get first call on federally produced power at the time it becomes available. But Interior will make long-time contracts with electric companies for sale of the remaining power.
- Interior will not permit the preference privilege to be used as a means to provide power for large industrial consumers at the expense of domestic and rural customers of electric companies.
- Federal power rates will be drawn to cover all costs of producing and transmitting power as well as retiring capital investment on power facilities.
- Interior will not seek to control the resale rates of power sold to preference customers, but may exercise control over resale rates of power sold to electric companies.

Flexibility Allowed . . . Interior Undersecretary Ralph Tudor said all power decisions which come out of Interior will bear the imprint of this general statement, but he was careful to note that the policy is broad enough to permit flexibility in arriving at specific decisions.

He also made it clear that the policy is no quick panacea to all of the department's power problems. He pointed out that such matters as the Georgia Power Co contract, the Kings River Case, and others are still pending before the department even though the general power policy has been put down in black and white.

. . . and the full Republican policy statement

1. Generating facilities

The primary responsibilities of the department are the reclamation of arid and semi-arid lands under the federal reclamation laws and the development of natural resources as authorized by Congress. These responsibilities include the disposal of surplus electric energy which can be economically produced in the course of the development of these resources. The Department of the Interior will, therefore, actively plan and recommend construction of generating facilities in hydro projects under its jurisdiction when such facilities are economically justified and feasible. The department will particularly emphasize those multipurpose projects with hydroelectric developments which, because of size or complexity, are beyond the means of local, public, or private enterprise.

It is recognized that the primary responsibility for supplying power needs of an area rests with the people locally. The responsibility of the Department of the Interior is to give leadership and assistance in the conservation and wise utilization of natural resources. The department does not assume that it has the exclusive right or responsibility for the construction of dams or the generation, transmission, and sale of electric energy in any area, basin, or region. In general, it will not oppose the construction of facilities which local interests are willing and able to provide in accordance with licenses and other controls of the Federal Power Commission or other regulatory bodies, and which are consonant with the best development of the natural resources of the area.

2. Transmission facilities

The Department of the Interior will construct and operate transmission lines that are economically feasible and necessary for proper connection and operation of federally owned generating plants. Transmission facilities will also be built and operated to carry power to load centers within economic transmission distances unless other public or private agencies have or will provide the necessary facilities upon reasonable terms. These terms shall generally be such that the federally produced power will be made available to customers at costs not higher than would result from the construction of transmission facilities by the federal government.

3. Preference to public agencies and co-ops

The Department of the Interior will operate the federally owned generating and transmission facilities under its control for the benefit of the general public, and particularly of domestic and rural customers, and the department will give preference and priority to public bodies and cooperatives in disposing of electric energy generated at federal plants. It will be the policy of the department to dispose of power, remaining after provision for existing preference customers, to privately owned public utilities serving domestic and rural customers in the area. The department will not ordinarily undertake to dispose of power directly to consumers except to carry out existing contracts or renewals or expansion thereof, nor will it use or permit the use of the preference privilege as a means to provide power for large industrial consumers at the expense of domestic and rural customers served by either publicly or privately owned public utilities.

4. Rates for sale of electric energy

The Department of the Interior will dispose of power and energy at the lowest possible rates to consumers consistent with sound business principles. Rate schedules will be prepared on a basis which will provide for the cost of producing and transmitting the energy and will return the capital investment in generation and transmission facilities together with interest in not more than 50 years. If reclamation costs are assigned to power, rates for power shall be such as to recover these additional costs within a reasonable time.

Rates will be reviewed at periodic intervals, generally not exceeding every five years, and at such times adjustments will be made to reflect actual costs where only estimates were available before, to reflect additions to the system which are in operation at the time of application of the new rates, and other proper items.

5. Resale rates of electric energy

Ordinarily in contracts with public agencies or cooperatives for the sale of electric energy no resale rate controls will be imposed by the Department of the Interior. It will be presumed that such bodies are responsible directly to customers they serve and are fully protecting the customers' interests.

In all contracts with customers other than public agencies or cooperatives, provision will be made to prohibit the resale of energy unless the purchaser is a public utility serving principally domestic and rural customers. In the latter event, provision will be made to insure that power is furnished to ultimate consumers at the lowest rates which shall reflect as nearly as possible the cost of the service plus a reasonable return on the investment at work.

Power Policy

Tudor and Assistant Secretary Fred G. Aandahl conducted a press conference on the policy statement in the absence of Secretary Douglas McKay, who is touring the Western states.

No Blank Check . . . While the policy bears the endorsement of the President, the cabinet, and most of the federal agencies dealing with electric power, there was no immediate indication it would be applied to departments other than Interior.

For instance, the main justification Tennessee Valley Authority has used for its power expansion is that it has a full utility responsibility. This policy statement expressly denies a utility responsibility for meeting electric power needs of an area. If such a policy is applied to TVA, its expansion plans would fall by the wayside.

One of the main purposes of the new policy, Tudor said, is to encourage the development of energy by public and private agencies. He made it clear that Interior construction agencies are not closing shop. The primary responsibility of Interior, he said, is to build multipurpose dams which are beyond the capacity of non-federal agencies.

Reclamation Bureau, an Interior agency, this fiscal year is carrying on a $174 million construction program of which some $63 million is to be spent directly or indirectly for electrical development and transmission.

Active Communist Cell . . .

. . . is reported by California legislative committee to be operating in San Francisco area public utilities. Pacific Gas & Electric dismisses five employees as "poor security risks"

Discovery of "an active Communist cell" in San Francisco Bay area public utilities was announced by California state Sen Hugh Burns (D, Fresno), chairman of the state Senate Un-American Activities Committee conducting investigations last week in San Francisco.

Called before the committee in closed door hearings were five employees of Pacific Gas & Electric Co and one Coast Counties Gas & Electric Co worker. Committee counsel Richard Combs said the committee started its investigation after receiving reports that "persons of doubtful loyalty" held positions with the utilities which would enable them to get "such important data as the location of heavy transmission lines which might be sabotaged."

Refuse to Talk . . . All six employees refused to answer the committee's questions on grounds that they might incriminate themselves. The committee recommended:

- That the utilities dismiss them as "poor security risks."
- That the San Francisco district attorney be requested to prosecute them on contempt charges.

PG&E went along with the suggestion and announced that they had given "the option of resignation or discharge" to the five employees—Joseph S. Chasin, cable splicer; Patrick Thomas Hancock, meter reader; Holden Hayden, lineman; Travis Lafferty, electrician; and Silas Stanley, substation second operator.

The utility said it had determined that "their presence on company property is detrimental to the best interests of the company and the public it serves."

The Coast Counties utility announced it would delay action on the dismissal recommendation until they received a transcript of the hearings and a statement of the union's position on the issue. Donald Powers, a head fitter employed in construction, operation and maintenance in their Contra Costa County region was called before the committee.

Protest Planned . . . The committee's legal right to seek contempt citations will be challenged by the attorney for one of the witnesses, who was granted 30 days in which to file the brief. This procedure will postpone contempt proceedings according to San Francisco's district attorney, who added that he has received no official request to prosecute the witnesses for contempt. He said the Un-American Activities Committee asked him to press contempt charges last year following a series of hearings, but he did not do so "because the transcript did not justify it."

Lafferty, one of the PG&E employees who figured in the hearing is vice chairman of Oakland unit of Local 1245, AFL International Brotherhood of Electrical Workers, and another, Chasin, is vice chairman of the San Francisco unit.

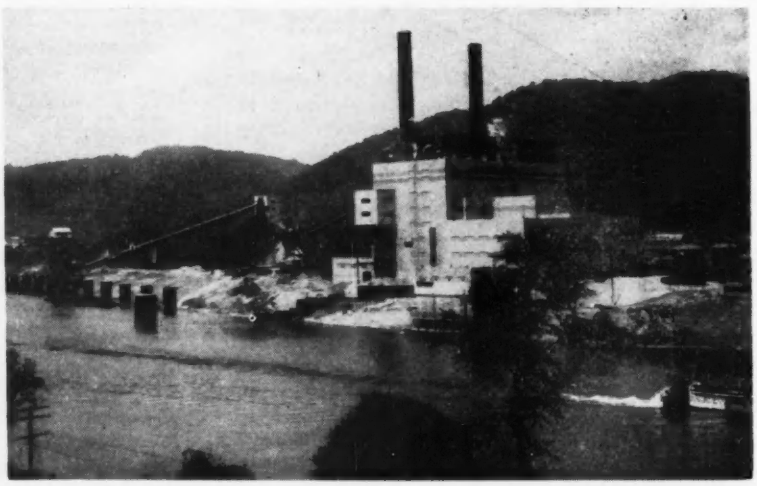
Most of the witnesses issued statements charging that the committee's "Communist probe" was actually "an attack on unions engaged in organizing public utilities workers."

The electrical union declared such statements "do not reflect the policy of our union." It issued a statement which said, "membership in the Communist party, or activities which are inimical to the best interests of our country, are grounds for a trial leading to expulsion from the union."

A union spokesman said the union is not attempting to pre-judge the loyalty or disloyalty of the witnesses. "Further hearings by our union will determine whether or not these members are disloyal," he said.

Screening Sought . . . Senator Burns said the committee is considering naming a contact man in each utility who would maintain liaison with the committee. "The purpose would be to exchange information on employees so that suspected subversives would be screened out."

The committee's agenda calls for further closed-door sessions in Los Angeles, to be followed at a later date by public hearings in San Francisco, according to Burns. He said the San Francisco sessions, now ended, convinced him that a full-scale investigation of possible Communist infiltration of the state's public utilities systems is warranted.



AG&E Puts New Plant on Line

The 200,000-kw Kanawha River Plant on the Kanawha River at Glasgow, W. Va., newest steam-electric generating plant in the seven state American Gas & Electric Co system, went on the line last week. The $46 million plant, owned and operated by Appalachian Electric Power Co, is linked to the AG&E system by the first 330-kv line ever built in the U. S. This brings AG&E system capacity to 3,219,000 kw. Another 920,000 kw is under construction, including a second 200,000-kw unit on the Kanawha.

Reclamation Faces Overhaul

Five-man survey team to make report in fall on tightening of Bureau into a smoother-working unit

Reshuffle of both the organization and operations of the Bureau of Reclamation is expected after a survey team now investigating the agency makes its report in the fall.

The five-man team, appointed earlier this month by Interior Secretary Douglas McKay, was given these responsibilities:

- To determine whether USBR is carrying out only legally assigned duties, or has assumed additional duties acquired through "wishful thinking."
- To decide whether the agency is performing its legally assigned functions in the most economical and effective manner.
- Recommend scope of Bureau activities required under existing law.
- Recommend any organizational changes that would improve efficiency and economy.

Deadline Near . . . Deadline of October 1 has been set for submission of the report. This would appear to offer little time for the task, but the team has a big advantage in that three of the five members are already intimately acquainted with Bureau organization and operations.

E. A. Moritz, chairman of the group, and R. J. Newell are both retired regional directors for the Bureau. Between them they have more than 62 years of active service in Bureau activities.

Mortiz retired in August of last year as director of the Pacific Southwest region of the Bureau with headquarters at Boulder City, Nev. Newell retired in June of 1949 as Columbia Basin regional director with headquarters at Boise, Idaho.

George Abbott, technical assistant on the House Interior and Insular Affairs Committee, has kept a close eye on Bureau activities from his legislative post on Capitol Hill.

A fourth team member, John G. Marr, was brought into the Interior Department by the new Republican Administration. He is serving as director of Interior's technical review staff.

Another outsider is John S. Crout, an engineer with the Battelle Memorial Institute of Columbus, Ohio. The Institute is a non-profit organization conducting research in science, engineering, and business practices.

Coast Exempted . . . Exempted from the study is the Bureau's California Projects Office, recently set up as the result of an earlier reorganization study of Region 2. This office is now functioning under the direction of C. H. Spencer, former construction engineer for the Hungry Horse project in Montana (EW, July 20, p 20).

The survey team was instructed to work out a program which will permit the reshuffle without seriously disrupting the necessary Bureau activities. Policy matters such as project investigations, findings of feasibility and initiation of construction are outside the jurisdiction of the team.

Among other things, the team is to consider recommendations made by a House Appropriations Committee staff earlier this year for Bureau reorganization.

Report of this committee staff found the Bureau is "greatly overstaffed with regional and district offices and personnel." It noted that Bureau personnel jumped from less than 7,000 in 1945 to more than 14,000 in 1946 and continued upward to 19,000 in 1950.

At the beginning of this year, Bureau employment was running about 13,800. Since the Republicans assumed control in January, the payroll has been sliced by another 1,400.

Republicans also reduced the Region 2 office at Sacramento, Calif., to a project office.

Cutback Urged . . . Appropriations Committee staff recommended that the seven regional offices in operation at the beginning of the year be reduced to three, and the 18 district offices be reduced to five.

It further recommended that the Washington activities of the Bureau be reduced to a liaison office, with Denver being made the main administrative center.

Organization proposed by the House committee staff would distribute Bureau regional and district offices in the following manner:

Region 1—Boise, Idaho
District—Ephrata, Wash.

Region 2—Boulder City, Nev.
District—Sacramento, Calif.
District—Salt Lake City, Utah.

Region 3—Denver, Colo.
District—Billings, Mont.
District—Bismarck, N. D.

Project Opposed

Four foes ask FPC to withdraw N. Y. Power Authority's license for St. Lawrence dam

Opponents of the St. Lawrence power project are asking Federal Power Commission to withdraw the federal license granted Power Authority of the State of New York.

The demand came in petitions for rehearing filed by four groups which have either opposed state construction or have taken exceptions to certain features of the proposed development, for which FPC issued a license in mid-July (EW, July 20, p 15).

Although it is likely that FPC will turn down the rehearing, the petition is a necessary preliminary to any court review of the licensing order. Courts have generally held that all administrative procedures must be exhausted before a case is ripe for judicial review.

FPC has 30 days in which to decide whether to reopen the case.

Petitioners Listed . . . Those asking for the rehearing are:

- Public Power & Water Corp of Trenton, N. J., which had a conflicting application before FPC for the St. Lawrence project.
- Central Pennsylvania Coal Producers Association, which opposes the New York license on grounds that the power project would reduce chances of an expanding coal market.
- National St. Lawrence Project Conference, an organization of coal and port interests which oppose project construction because of conflicting interests.
- Lake Ontario Landowners & Beach Protective Association, which has expressed fear that the power project will raise the lake level and damage property owned by association members.

Electric Furnaces

. . . would make millions for power, coal, steel industries, combined survey indicates

The coal, steel and utility industries would stand to gain many million dollars a year if the country's open hearth furnaces were replaced by electric furnaces, according to a two-year survey just completed by Bituminous Coal Research, Inc, and fourteen electric utility companies.

Members of the electric and coal industries, knowing both would benefit if electric furnaces replaced open hearths, combined two years ago to conduct a study to find out whether the electric furnace could compete. The stake is large: about 83 million tons, or 89%, of the country's steel, most of it low-carbon, is made in open hearths.

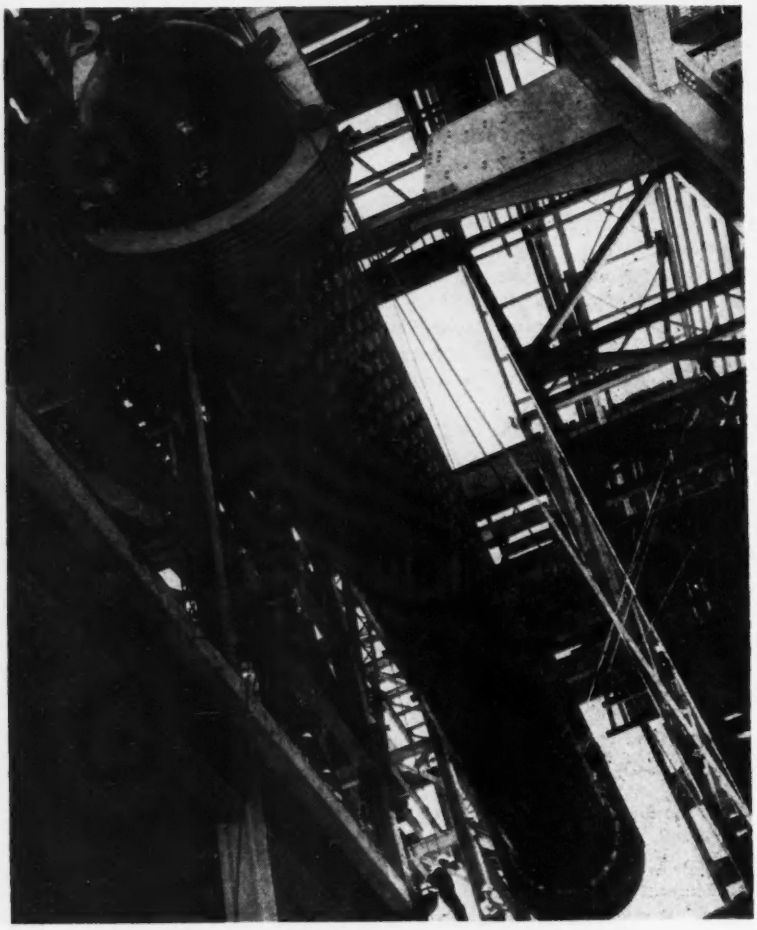
Result Estimated . . . The group studied three plant sizes, the first producing 250,000 tons annually, the second 500,000 tons and the third 1 million tons. The following estimates were announced today:

Replacing open hearths with electric furnaces could (1) decrease cost of making low-carbon steel from cold metal as much as $3.15 a ton, (2) increase national output of electricity by 12%; and (3) increase coal production by about 25 million tons a year. The latter two estimates assume replacement of the 950 open hearth furnaces by 700 electric furnaces.

Open hearths are fired primarily with oil; electric furnaces operate on power usually generated from coal. Future changes in costs of fuels and metals used by the electric furnace and the open hearth are expected to favor the former, according to the survey.

19 Million Kw Needed . . . Supplying power for the electric furnaces for the maximum potential steel tonnage would mean installation of 19 million kw of additional capacity, the group estimated. To build and equip these power generation facilities would take an investment of $3 billion, not including transmission. The electric furnace installations would mean more than $1 billion in sales by manufacturers of furnaces and auxiliaries, the group estimated.

Electric companies taking part in the survey included: Alabama Power, Cincinnati Gas & Electric, Cleveland Electric Illuminating, Commonwealth Edison/Public Service of Northern Illinois, Detroit Edison, Duquesne Light, Ohio Edison, Ohio Power, Pennsylvania Electric, Pennsylvania Power & Light, Philadelphia Electric, Public Service Electric & Gas, and West Penn Power.



Drumming Up a 10-Story Story

Focal point of a plumber's nightmare: Hoisting 175 ton steel boiler, designed to accommodate operating pressures up to 2,050 psi, into place at Pacific Gas & Electric Co's Pittsburg steam plant. The massive yoke of laminated steel will support the drum from heavy beams built into the top of the boiler house for that purpose. Four drums will be installed, one for each unit of the 600,000 kw plant. To ease the job of connecting miles of pipe to the drums, the holes are numbered so that each loop of pipe, running up and down the 10-story boiler furnace, will be fitted into its proper place.

Puget Sound P&L Orders Study on Proposed Plant

The Puget Sound Power & Light Co of Seattle has authorized the Stone & Webster Engineering Corp to make a preliminary investigation and report on the economic feasibility of building a $10-million steam power plant at Anacortes, Wash.

The plant would be intended primarily to supply steam and power for a $75-million oil refinery to be constructed at Anacortes by the Shell Oil Co, although a "substantial block" of power would be available for other use. Undoubtedly a factor in Puget Power's move is the action of the General Petroleum Corp, already building a $45-million refinery at nearby Ferndale, in turning to the PUDs for power when it was unable to get an assurance of firm power from Puget Power (see facing page).

Power Interchange

. . . Two PUDS arrange to supply power to oil refinery under construction

An arrangement under which the Whatcom County PUD of Bellingham, Wash., will obtain power from the Pend Oreille County PUD of Newport, Wash.—some 300 miles away—for supply to a $45-million refinery under construction by the General Petroleum Corp has been revealed with a call for bids by the Whatcom PUD on necessary equipment.

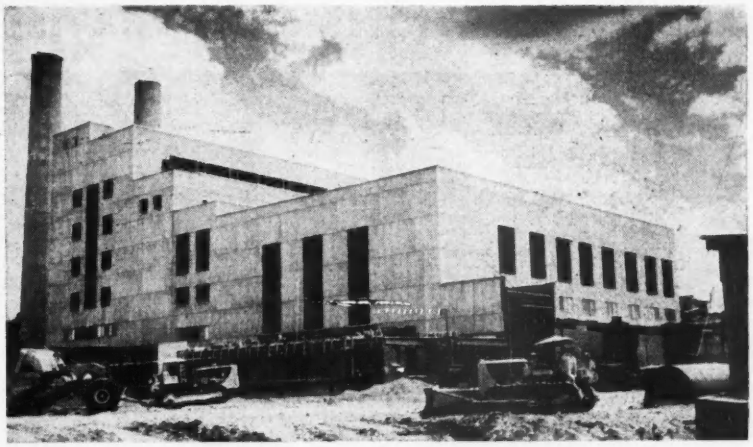
The PUD will receive bids until Aug. 27 for two three phase, 60 cycle transformers, 10,000 kva each, 115 kv to 13.8 kv, for installation in a $275,000 substation at nearby Ferndale. Bids will be called later for a 13.3-mi. 115-kv transmission line from Bellingham to the substation. One of the transformers is necessary as a standby, the refinery operation demanding such a precaution.

The Supply . . . Power will be supplied by Pend Oreille PUD from Box Canyon Dam scheduled for completion next July and "wheeled" to Bellingham over Bonneville Power Administration lines. The contract calls for 8,000 kw of firm power to be available by Sept. 1, 1954, with the refinery expected to require several thousand additional kw within a few years.

General Petroleum Corp, after first attempting to buy power from the Puget Sound Power & Light Co and Bonneville, had considered installing its own power plant before reaching the agreement with the PUDs.

Although the Whatcom County PUD has been in existence since the mid-1930s, this will be its first experience in power operation. It won a condemnation award against Puget Power properties at one time but rejected it as too high and last year withdrew from a PUD attempt to buy Puget Power.

PUD's Position Considered Good . . . With the new substation, the PUD is expected to be in a good position to supply power to other industries which may be attracted by the refinery. Only a third of the power to come from the Pend Oreille PUD's Box Canyon Dam is believed to be committed to date.



Source of Power for H-Bomb Plant

South Carolina Gas & Electric Co's Urquhart Station, above, will start producing power for Atomic Energy Commission's H-bomb plant near Augusta, Ga., soon. First 75,000-kw unit will be completed in September and the second in November. The power plant is located on the South Carolina side of the Savannah River. Power not required by AEC will be fed into the SCG&E system.

Hurricane Does $150,000 Damage to Carolina P&L

An army of linemen recruited by Carolina Power & Light Co was ready in the field when Hurricane "Barbara" struck the coast of North Carolina at 100 mph this month. The advance preparation helped keep damage down to $150,000.

A company spokesman reported that this "army," which suffered no casualties, had restored service in the hardest hit areas of Cherry Point Marine Base, Morehead City, and Beaufort in time for 50 to 60% of the utility's customers to have breakfast the following morning. These areas had outages on two 33-kv transmission lines. New Bern, northwest of Cherry Point, also suffered a 40-minute outage on a 33-kv line.

Just before the hurricane struck about 5 p. m., Aug. 13, two crews of 100 men, equipped with an extra radio truck, one crew from Kinston, and another radio equipped truck from Wallace left Wilmington destined for Morehead City. While enroute, these units were told by radio to go to Cherry Point, the other end of the transmission line. Cherry Point reported winds of 98 mph tore down trees and snarled power and communication lines. Strong gusts and rain prevented for some time the mobile units and local crews from working on the outages.

At Morehead City, one regular crew was aided by three crews that belonged to a contractor doing work for the utility and a private tree company crew. Service in this coastal city was reestablished at 5:17 a.m. the following morning. By Saturday morning complete service was restored.

Trees were blown down with many just toppling over after surrounding soil became soft from heavy rains.

California Oregon Power Orders 2 Package Plants

California Oregon Power Co, Medford, Ore, has ordered from Westinghouse Electric Corp two automatic hydroelectric package power plants to be installed on the North Umpqua River. The total contract is for $1,175,000.

The new plants, to be constructed at the utility's Lemolo No. 1 and No. 2 generating stations east of Roseburg, will add 62,000-kw to the lines.

Lemolo No. 1, a single unit 29,000-kw outdoor automatic plant, is to go into operation in 1954. Lemolo No. 2, a single unit 33,000-kw outdoor installation, is slated for completion in 1955.

PUBLIC RELATIONS & ADVERTISING

Utility Provides Recreational Area

A recreational and picnic ground on the shores of Lake Murray near the Saluda Dam of South Carolina Electric & Gas Co has been opened to the public by the company. The site, 15 miles northwest of Columbia, contains about two acres.

There are five parking areas, a beach, and a boat basin. Seven picnic shelters are located in the wooded area of the project. Each is equipped with a large table and a dutch oven. The area is lighted for evening use. The concession stand has been leased to the Lexington (S. C.) Junior Chamber of Commerce without charge.

All policing of the grounds and all maintenance work is done by the employees of the Saluda hydro plant located nearby.

AD COPY THEMES

Alabama Power Co—Under a headline, "What Is It?" was run a series of questions such as "What is it that brings you entertainment at the turn of a dial?" The answer was provided under a 72-point subhead reading "This Is It!" The "it" was described as electric power. The ad elaborates on the company as a reliable source of electric power.

Georgia Power Co—"We Gave a Hot-foot to a Million Potato Plants!" This ad was a testimonial from a farmer telling how a Georgia Power rural engineer designed for him ten electric hotbeds.

Northern States Power Co—"Which Woman Is Your Wife?" This question headed an ad for roomy electric refrigerators. Illustration consisted of two drawings: one of a woman getting some snacks from a crowded out-of-date refrigerator, the other of a woman getting the snacks out of a roomy, modern job.

Pennsylvania Power & Light Co—An outline of an electric hot water heater filled a 2-col, 20-in. ad. Ripples simulating water filled the tank to the head reading, "Hot Water up to here." Down right side was this message, "at prices way down here, 1¢ per kilowatt hour."

Wisconsin Electric Power Co—Using Reddy Killowatt, company has been running an attractive series of ads on adequate wiring and the low cost of 220-v service.

Booklet Aiding Utility in Fight for Graduates

"Opportunity" is the latest weapon put on the firing line by Texas Electric Service Co in its fight for recent college graduates. The utility is competing for them against the oil, chemical, and other industries which are growing so rapidly in its service area.

"Opportunity" is the title of a two-color booklet which stresses the advantages of working for the utility. The illustrations are pictures of recent graduates at work for the company in various capacities.

The booklet is distributed at interviews with prospective employees, through college placement bureaus, and by mail to those writing seeking employment.

Easier Parking Idea

A Minocqua, Wis., gas station owner has an idea that might be of value to electric companies whose offices are in congested districts where parking is difficult. He has erected a sign advising customers of Wisconsin Public Service Co to park at his station "for gas while paying your light bill across the street." He gets the gas business. The utility's customers get a more convenient parking place.

Owners Live in State

Pacific Gas & Electric Co wants all of its employees to know that they are working for a California company owned by Californians. In the August issue of "P.G. and E. Progress" there is an article pointing out that 131,091 of the company's 198,330 stockholders are residents of the state. A county map of the state shows the number of stockholders residing in each county.

Reddy Signs AG&E Group

Acting separately the seven operating companies of the American Gas & Electric System have signed contracts for the Reddy Kilowatt Service. The contracts will become effective at various times in the coming three months. The combined companies serve over a million electric customers.

WASHINGTON COMMENT

JESSE MOCK

Few Power Laws Got Approval of 83rd Congress

At the half-way mark, the Republican 83rd Congress can claim no dramatic accomplishments in the field of electric power legislation. But through a series of actions—some minor, some inconclusive — the Congress which adjourned early this month clearly stamped the GOP symbol on the federal power program.

In general the new attitude is less emphasis on federal power development and marketing and slightly less regulation of non-federal electric utilities. One or two moves toward a clean break with New and Fair Deal power policies are in the mill, but the outcome remains for future determination.

Congress Approved These Power Laws . . . A rundown of power actions by the 83rd Congress gives you some ideas of the trend. First, take the actual and conclusive accomplishments:

Appropriations voted for federal power facilities were roughly 25% less than requested by the former Democratic administration.

Restrictions imposed on Southwestern Power Administration continuing fund limit the activities of that agency in the purchase and transmission of power.

A $5 million fund voted for small upstream flood control might possibly decrease the need for large, high-cost, multipurpose dams on main streams.

Two minor amendments to the Federal Power Act limit Federal Power Commission regulation to some extent. One of these would ease the 50-year recapture clause as it applies to accounting on publicly owned hydroelectric projects. The other exempts from FPC jurisdiction electric systems which interconnect with foreign systems if the systems are otherwise confined to a single state.

But Unapproved Legislation Is More Impressive . . . More impressive is the list of unfinished business which Congress has left over from the first session:

Electric company development of additional power at Niagara Falls—The House gave this bill an overwhelming vote of approval, but its fate in the Senate remains uncertain.

A thorough evaluation of federal responsibility in the power field—Congress created the new Hoover Commission to go into this tremendous problem, but commission recommendations will not come until late 1954. Implementing legislation will be the business of the 84th and later Congresses.

Action to permit Oklahoma to build the Markham Ferry project, with a federal contribution for the flood control features, would lessen federal responsibility for that project. This bill was on the House calendar at adjournment after passing the Senate.

The move to give Congress control over authorization of smaller Reclamation Bureau projects is pending before the House.

Congress urged some federal responsibility in spreading the cost of abnormal steam generation costs in the Pacific Northwest in critical water years but made no detailed suggestions.

That is pretty much the record of the Republican Congress up to now.

It has drawn scathing criticism from a number of the strong public power advocates in both houses. In fact, these critics such as independent Sen Wayne Morse of Oregon have received considerably more public attention than have the men who have written the GOP legislative power program.

In a few instances, particularly in regard to appropriations cuts, sharp criticism has come from affected sections of the country. For instance, Tennessee Valley Authority supporters put up a fight to restore funds for that agency. There were a few bitter protests from rural electric co-op officials and leaders over the SPA continuing fund restriction.

But up to now opposition to Congressional moves in the power field has been confined to a few lawmakers and groups in areas directly affected by reduction in federal appropriations. Several recent public opinion pools indicate that a majority of the voters are generally satisfied with the record the Republican Congress has written thus far.

TECHNICAL NOTES

ARCHER E. KNOWLTON

Current transformers in industrial plants with local generators and a multiplicity of small feeders may be subjected to symmetrical short circuit currents as high as 200 times their rating. Multiples of 50 to 100 times are common.

Line-to-line fault at the terminals of a generator causes negative-sequence current components of maximum magnitude. The flux established induces double-frequency rotor currents in the surface of the rotor forging, the coil retaining wedges and rotor end-rings.

Lightning arresters are needed close to 330-kv transformers despite the reduction in severity of surge voltages within the station because of appreciably long tap connections.

Transformer noise measurements and human sensibility to the noise unfortunately do not generally correlate well. Instruments are insufficiently psychotic.

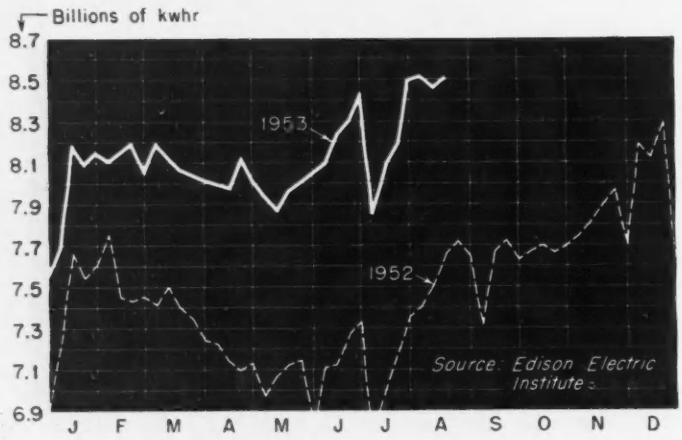
Oil in transformers on a power system amounts to about 2.4 gallons for each kw of its generating capacity.

Vertical masts and overhead ground wires appear to be equally favored as methods of protecting stations and substations from direct lightning strokes.

Noise from rotating machines can be minimized by reducing the sound transmitted. To achieve this it is essential to have the natural mechanical frequency of any part well separated from any of the forcing frequencies.

Electrification with hydro power of a 320-mile French railway is promising to save 500,000 tons of coal per year while providing express service in 4¼ hours (i.e. 75 mph).

STATISTICS



Output Week Ended Aug. 15—8,513,782,000 Kwhr

Per Cent Change From Previous Year

	Total US	New Eng.	Mid. Atlan.	Cent. Ind.	West Cent.	South-east	South Cent.	Rocky Mount.	Pacific NW	Pacific SW
Aug. 15	+11.6	+8.4	+6.2	+12.3	+7.9	+21.3	+7.5	+8.8	+7.5	+10.2
Aug. 8	+12.9	+6.4	+5.6	+16.6	+11.2	+25.3	+7.1	+7.6	+8.8	+6.4
Aug. 1	+14.9	+9.5	+10.1	+21.3	+13.6	+22.5	+6.5	+9.4	+9.4	+10.1

Electric Power Statistics

		Latest Month	Preceding Month	Year Ago
Peak Load (Million Kw)	May	73.5	72.9	65.9
Capacity (Million Kw)	June	85.06	84.34	77.46
Production (Billion Kwhr)	June	36.83	35.98	31.53
Hydro	June	9.10	10.29	9.16
Fuel	June	27.73	25.69	22.37
Fuel Consumption				
Coal (Million Tons)	June	9.06	8.59	7.66
Oil (Million Barrels)	June	6.12	6.09	3.91
Gas (Billion Cu Ft)	June	103.73	87.85	89.29
Sales (Billion Kwhr)	May	31.32	31.75	27.94
Residential	May	8.50	8.86	7.52
Commercial	May	5.18	5.15	4.74
Industrial	May	15.49	15.46	13.83
Other	May	2.16	2.28	1.86
Net Income Class A & B Companies ($ Million)	June	77.82*	82.13	71.03
Estimated Dec. '53 Peak (Million Kw)	May	86.1	86.5	88.4
Kwhr per Residential Customer (12 Month Average)	Apr.	2,224	2,209	2,066
Revenue per Kwhr Residential Service (12 Month Average)	Apr.	2.76¢	2.76¢	2.79¢
Canadian Production (Billion Kwhr)	May	5.76	5.75	5.33

Business Statistics

FRB Industrial Production Index†††	June	243*	241	205
Gross National Product Annual Rate ($ Billion)	1stQtr.	363.4	361.1	339.7
EW 5 Industry Production Index	June	130.4	130.0	97.1
ENR Construction Cost Index††	July	126.6	124.4	119.6
BLS Consumer's Price Index	June	114.5	114.0	113.4
NEMA Insulation Materials Sales Index†	May	631	694	517
NEMA Electric Appliance Sales Index†	May	299	317	219
NEMA Household Refrig. Sales Index†	May	158	188	128
Metal Prices (Aug. 18)				
Copper, Conn. V., lb		$ .28½-.30	$ .29¾	$ .24
Lead, N. Y., lb		.14	.13½	.16
Zinc, prime Western E. St. Louis, lb		.11	.11	.14
Tin, Straits, qual. N. Y. lb		.83	.79¾	1.21½
Aluminum, ingot, base price		.21½	.20½	.20
Nickel, base price		.60	.60	.56½
Steel, billets, Pitts., ton		62.00	62.00	56.00
Steel, scrap, No. 1 heavy, Pitts., ton		44.00-45.00	43.00	45.00

*Preliminary **Revised †1936=100 ††1949=100 †††Unadjusted

Business Inventories Rise $2.8 Billion

Book value of business inventories at the end of June was $2.8 billion above that of the first of the year according to a study released by the Department of Commerce. This estimate allows for seasonal variation. Inventories now stand at $77 billion.

Of the $2.8 billion rise during the first half about $700 million occurred during June. This June increase in book values centered in manufacturing. It reflected, in part, higher inventory costs. Trade stocks were up less than $200 million.

Durable and nondurable goods stocks rose equally during June. The durable-goods increase mainly was at the manufacturing level, as a small rise in retailers' stocks offset a decline at wholesale establishments.

Increase in nondurable-goods stocks was about the same for manufacturers and wholesalers.

Retailers' inventories at the end of June amounted to $21.4 billion, about $100 million above the May seasonally adjusted rate. Most major groups of durable-goods retailers reported, however, stocks were only slightly higher than the end of the previous month.

June Total Business Inventories Seasonally Adjusted

	Millions of Dollars 1953	1952
Total	77,550	72,558
Manufacturing	45,496	42,972
Durable	25,799	23,518
Nondurable	19,696	19,454
Wholesale	10,399	9,761
Durable	5,274	5,005
Nondurable	5,125	4,756
Retail	21,655	19,825
Durable	10,322	9,229
Nondurable	11,333	10,596

Source: Dept of Commerce

June Total Business Sales Seasonally Adjusted

	Millions of Dollars 1953	1952
Total	49,244	43,694
Manufacturing	26,118	21,640
Durable	12,949	10,284
Nondurable	13,169	11,356
Wholesale	8,621	8,240
Durable	2,892	2,728
Nondurable	5,729	5,512
Retail	14,505	13,814
Durable	5,120	5,122
Nondurable	9,385	8,692

Source: Dept of Commerce

FINANCIAL

WWP-Puget Hearings End . . .

. . . before the Washington State PSC. Puget Sound's general counsel asks that the merger be approved

In the closing argument before the Washington Public Service Commission on the proposed Puget Sound Power & Light Co merger into Washington Water Power Co, Puget's General Counsel Lowell P. Mickelwait requested the merger be approved (EW, Aug. 17, p 48).

He stated that the Washington statute relating to approval for mergers does not prescribe the test that is to be applied by the PSC in determining whether or not the merger should be approved. However, the general counsel said, the PSC has adopted the following rule which specifies the test to be applied:

"Transaction must be consistent with public interest. If, upon examination of any application and accompanying exhibits, or upon a hearing concerning the same, the Department finds that the proposed transaction is not consistent with the public interests, it shall deny the application."

Consistent with Public Interest . . . In defining the phrase "consistent with the public interest," he read a quotation from the PSC's order in a proceeding involving the merger between Northwestern Electric Co and Pacific Power & Light Co as follows:

"The rule is stated in the negative. The Director may not deny application unless he affirmatively finds that the proposed transaction 'is not consistent with public policy.' Bearing this consideration in mind, the words of the Circuit Court of Appeals for the Ninth Circuit construing Section 203(a) of the Federal Power Act are particularly instructive.

"The phrase 'consistent with the public interest' does not connote a public **benefit** to be derived or suggest the idea of a **promotion** of the public interest. The thought conveyed is merely one of **compatibility** . . . It is enough if the applicants show that the proposed merger is **compatible** with the public interest. The PSC, as a condition of its approval, may not impose a more burdensome requirement in the way of proof than that prescribed by law." (Emphasis supplied)

Pertinent Facts Presented . . . Puget's general counsel continued by saying:

"In Puget's presentation of evidence before this commission, we have produced what we regard as the pertinent facts relating to Puget in order to permit this commission to decide whether this merger is consistent with the public interest. We are taking no stand as to alleged benefits or savings resulting from the merger. It is primarily the responsibility of WWP because it is to be the surviving corporation and would have complete control of the management and operation of the merged property."

After reviewing the nature of the testimony submitted and summing up and evaluating the evidence in the record regarding Puget, he stated:

"Winding up as to Puget's position in this proceeding, I believe the record here speaks for itself, and they say our actions speak louder than our words. We have done the following: We have negotiated the terms of the merger agreement. We have cooperated in the preparation of the S-1 registration statements that are here in evidence. A majority of the Puget directors have signed the merger agreement. We have submitted our application to this commission requesting authorization for the merger. We have presented the evidence, and every bit of that evidence we considered pertinent to this proceeding or we were requested to produce.

"Furthermore, so that the commission might not operate in a vacuum, we extended the merger agreement from July 30 to Nov. 19 so that this commission would have an opportunity to make its determination.

"Therefore, in conclusion, I request on behalf of the Puget Sound P&L that the application be granted."

Condemnation of Dam . . . Earlier L. J. Richardson, president of the Chelan Public Utility District, declared his group would attempt condemnation of Puget's Rock Island Dam in event of the merger, feeling WWP to be "unfriendly." Puget Power now operates six additional power units which were installed in the Rock Island Dam several years ago at PUD expense to provide power for a new aluminum plant near the dam.

Asked if the Chelan district would be willing to operate as at present if the dam agreement with the merged company were the same as that now in effect with Puget Power, Richardson said such an agreement would be considered. He earlier had said the PUD would operate its units separately in the event of a merger.

Private power was successful in blocking an attempt of the PUD association to prove that the proposed purchase of Puget Power by the five PUD's would be more in the public interest than would the merger. Alan Paine and Lowell P. Mickelwait, attorneys for the two power companies, contended such testimony would be immaterial and irrevelant as the purchase plan was not a part of the merger hearings.

Chelan PUD's six generators in the Rock Island Dam earned a net income of $238,622 from Sept. 4, when the first unit went into operation, through the first half of this year, PUD officials have announced.

May, the first month in which all six of the 22,500-kw generators were operated, saw the production of 92 million kwhr. Alcoa plant gets 120,000 kw from the installation on a firm basis. When that much power isn't available, Bonneville Power Administration makes up the difference. When the PUD has a surplus, the additional power goes to Puget Power.

WWP Pays Another Dividend . . . WWP has declared a third quarter dividend of 40¢ a share payable Sept. 15 to shareholders of record Aug. 25. A similar payment was made June 15. Last year, WWP paid three dividends of 30¢ each and a final quarterly dividend of 37½¢.

WWP's Pres Kinsey Robinson, who is under unofficial SEC instructions not to comment publicly in a manner that would affect WWP stock, has urged the Federal Power Commission to begin its hearing on the merger Sept. 14. The state of Idaho has already approved the merger.

Indiana Utility May Sell Preferred Stock Privately

Securities and Exchange Commission is permitting Indiana & Michigan Electric Co, a subsidiary of the American Gas & Electric System, to explore the possibility of issuing $5-$7 million worth of preferred stock through negotiated underwriting rather than competitive bidding.

With few exceptions, the regulatory body has required competitive bidding for stock and bond issues of utility holding company and subsidiaries. The recent action may indicate some easing of the competitive bidding rule, but observers are awaiting final SEC action on the matter before drawing any conclusions.

These factors are involved in the Indiana & Michigan action:

1. The preferred stock issue is subject primarily to regulation by a state commission. Under the holding company act, the issue is entitled to exemption from strict SEC rules but still subject to conditions set down by the federal agency.

2. There have been a few recent cases where competitive bidding has not proved as successful as was expected.

3. The action involves preferred stock only. SEC would probably take a different view if bonds or common stock was involved.

FINANCIAL BRIEFS

Public Service Co of New Hampshire has announced that as a result of the distribution of assets of the New England Public Service it is no longer a subsidiary of a holding company.

Electric Energy, Inc, has asked SEC approval to borrow up to $30 million until June 30, 1954 from five banks with Chase National Bank and Guaranty Trust Co to take $11 million each.

Ireton, Iowa, citizens vote 124-to-1 to extend the franchise 25 years for the Iowa Public Service Co . . . **Portageville, Mo., citizens** vote for a seven year franchise for the Arkansas-Missouri Power Co . . . For a study on "Electric Utility Company Common Stocks," write Ted Locke, Goodbody & Co, 115 Broadway, New York 6, N. Y.

Today in Utility Finance

YIELDS (%)

Quality	Bonds			Preferred Stocks			Common Stocks		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
DATE									
1953									
Aug. 13	**3.26**	**3.31**	**3.51**	**4.31**	**4.48**	**4.77**	**5.30**	**5.60**	**5.79**
Aug. 6	3.26	3.32	3.50	4.31	4.47	4.76	5.36	5.62	5.74
END OF QTR									
2nd 1953	3.34	3.46	3.64	4.47	4.70	4.88	5.52	5.93	6.10
1st 1953	3.15	3.23	3.39	4.16	4.41	4.66	4.95	5.24	5.50
4th 1952	2.99	3.03	3.14	4.06	4.22	4.59	4.98	5.33	5.62
3rd 1952	2.99	3.03	3.16	4.10	4.26	4.61	5.18	5.59	5.96

Data: Reis & Chandler, Inc.

EARNINGS

Company	Period Months Ended		Net Income 1953	Net Income 1952	Earnings Per Common Share 1953	Earnings Per Common Share 1952
Arkansas-Missouri Power	12	June	$819,544	$611,513	$....	$....
Columbus & Southern Ohio Electric	12	June	5,257,807	4,113,165	2.25(a)	2.16(a)
Duquesne Light	12	June	14,622,223	13,643,487	2.17(b)	2.07(b)
Kentucky Utilities and subsidiaries	12	June	4,705,114	4,206,399	....	....
Michigan Gas & Electric	12	June	466,038	443,035	2.88	2.72
New York State Electric & Gas	12	June	8,097,303	7,269,676	2.57	2.30
North American, consolidated	12	June	11,418,807	10,635,491	1.33	1.24
Northern States Power (Minn.) and subsidiaries	6	June	8,799,217	7,723,757	0.61	0.57
Pennsylvania Water & Power	6	June	644,998	740,362	1.16	1.33
Public Service of Colorado	12	June	8,079,804	6,826,364	2.48(c)	2.06(c)
Public Service of New Mexico	12	June	1,173,857	1,010,669	0.82(e)	0.83(e)

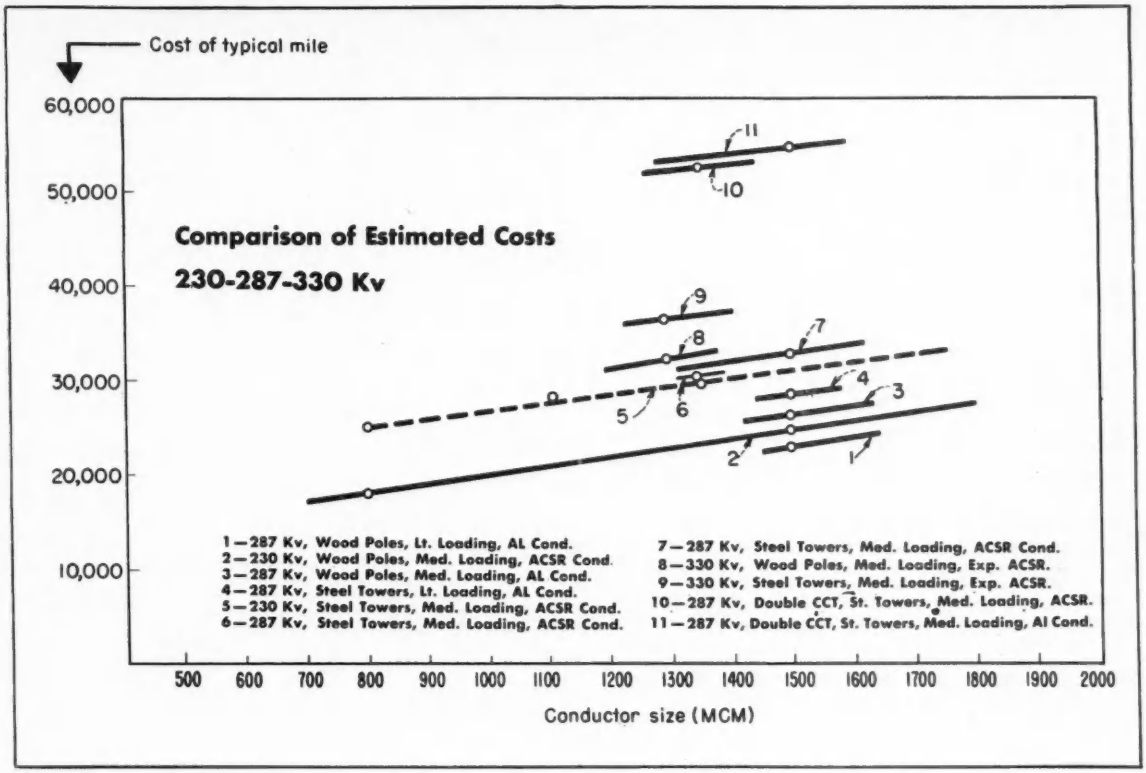
Notes—(a) Based on 2,001,360 shares in 1953 and 1,701,360 shares in 1952; (b) Based on shares outstanding at the end of each period; (c) Based on 2,754,639 shares in 1953 and 2,746,592 shares in 1952 and (e) Based on 1,385,092 shares in 1953 and 1,211,956 shares in 1952.

FINANCING

Company and Description	Amount of Offering ($000)	Offering Price	Yield to Public
SCHEDULE FOR AUGUST—SEPTEMBER—OCTOBER			
Bonds			**Bid Date**
Southern California Edison—1st mtg due 1978	$30,000	.....	Aug. 25
Wisconsin Power & Light—1st mtg due 1983	8,000	.....	Aug. 31
Duke Power—1st and refunding mtg due 1983	35,000	.....	Sept. 1
Crawfordsville, Ind., electric revenues 1956-74	1,350	.....	Sept. 8
Louisiana Power & Light—1st mtg due 1983	12,000	.....	Sept. 16
Duquesne Light—1st mtg due 1903	12,000	.....	Sept. 22
Mississippi Power—1st mtg due 1983	4,000	.....	Oct. 6
Debentures			
Central Hudson Gas & Electric—conv debs due 1963	$6,000	.....	Sept. 9
Preferred Stock			
Duquesne Light—100,000 sh $50 par	$5,000	.....	Sept. 17
Wisconsin Power & Light—20,000 sh $100 par cum (to be offered 4½% and 4.80% preferred holders record Aug. 14 to expire Sept. 8 without limit; an oversubscription will necessitate an allotment)	2,000	.....	.....
Common Stock			
Wisconsin Power & Light—329,194 sh (to be offered commonholders on 1-for-7 basis, record Aug. 14 to expire Sept. 8)	$.....	$.....	.....
Duke Power—208,321 sh (to be offered commonholders on 1-for-20 basis, record Sept. 2 to expire Sept. 18 without underwriting)	6,250	30.00	5.00%
Central Hudson Gas & Electric—139,978 sh (to be offered commonholders on 1-for-15 basis, record Sept. 9 to expire Sept. 25)	.....	.....	.....
Central Illinois Public Service—350,000 sh	.....	.....	Sept. 9
Duquesne Light—150,000 sh	.....	.....	Sept. 15
New England Gas & Electric—194,916 sh (to be offered commonholders on 1-for-10 basis, record about Sept. 30)	.....	.....	.....
Hartford Electric Light—105,500 sh	.....	.....	.....
POSTPONED, UNSCHEDULED, AND/OR UNDER CONSIDERATION			
Bonds			
Public Service Electric & Gas—1st mtg due 1983	$50,000	.....	.....
Kansas Gas & Electric—1st mtg due 1983	10,000	.....	.....
Indiana & Michigan Electric—1st mtg	15,000	.....	.....
Southwestern Public Service—1st mtg	12,000(e)	.....	.....
Preferred Stock			
Kansas Gas & Electric	$5,000	.....	.....
Indiana & Michigan Electric	5,000(b)	.....	.....
Southwestern Public Service	3,000(e)	.....	.....
Common Stock			
Iowa-Illinois Electric & Gas	$6,000(a)	.....	.....
Western Massachusetts Electric	4,000(e)	.....	.....
Southwestern Public Service—(to be offered on about a 1-for-13 basis)	.....	.....	.....
New York State Electric & Gas—337,118 (to be offered commonholders on 1-for-8 basis)	.....	.....	.....

Notes—(a) To sell enough common stock to yield $6 million; (b) SEC has given SEC approval to sell $5-$7 million either privately or competitively; (e) Estimated.

230 kv. Wood Tangent Structure
No. units per string 12


Cost of typical mile
60,000
50,000
40,000
30,000
20,000
10,000
Comparison of Estimated Costs
230-287-330 Kv
1—287 Kv, Wood Poles, Lt. Loading, AL Cond.
2—230 Kv, Wood Poles, Med. Loading, ACSR Cond.
3—287 Kv, Wood Poles, Med. Loading, AL Cond.
4—287 Kv, Steel Towers, Lt. Loading, AL Cond.
5—230 Kv, Steel Towers, Med. Loading, ACSR Cond.
6—287 Kv, Steel Towers, Med. Loading, ACSR Cond.
7—287 Kv, Steel Towers, Med. Loading, ACSR Cond.
8—330 Kv, Wood Poles, Med. Loading, Exp. ACSR.
9—330 Kv, Steel Towers, Med. Loading, Exp. ACSR.
10—287 Kv, Double CCT, St. Towers, Med. Loading, ACSR.
11—287 Kv, Double CCT, St. Towers, Med. Loading, Al Cond.
500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000
Conductor size (MCM)

WOOD STRUCTURES LOWER COSTS in this comparison of 230-387-330 kv lines based on estimates of Alabama Power Co engineers

Cost Studies Point Way to . . .

Design Economies In High Voltage Transmission Lines

Methods used by Alabama Power disclose that in its area wood or wood and steel produce more economical structure than steel alone. Their approach is applicable everywhere

L. B. MURRAY and C. P. USSERY
Alabama Power Co, Birmingham, Ala.

Alabama Power Co's recently completed studies of high voltage system costs have disclosed that the use of wood, or a combination of wood and steel, produces a more economical structure than an all steel tower.

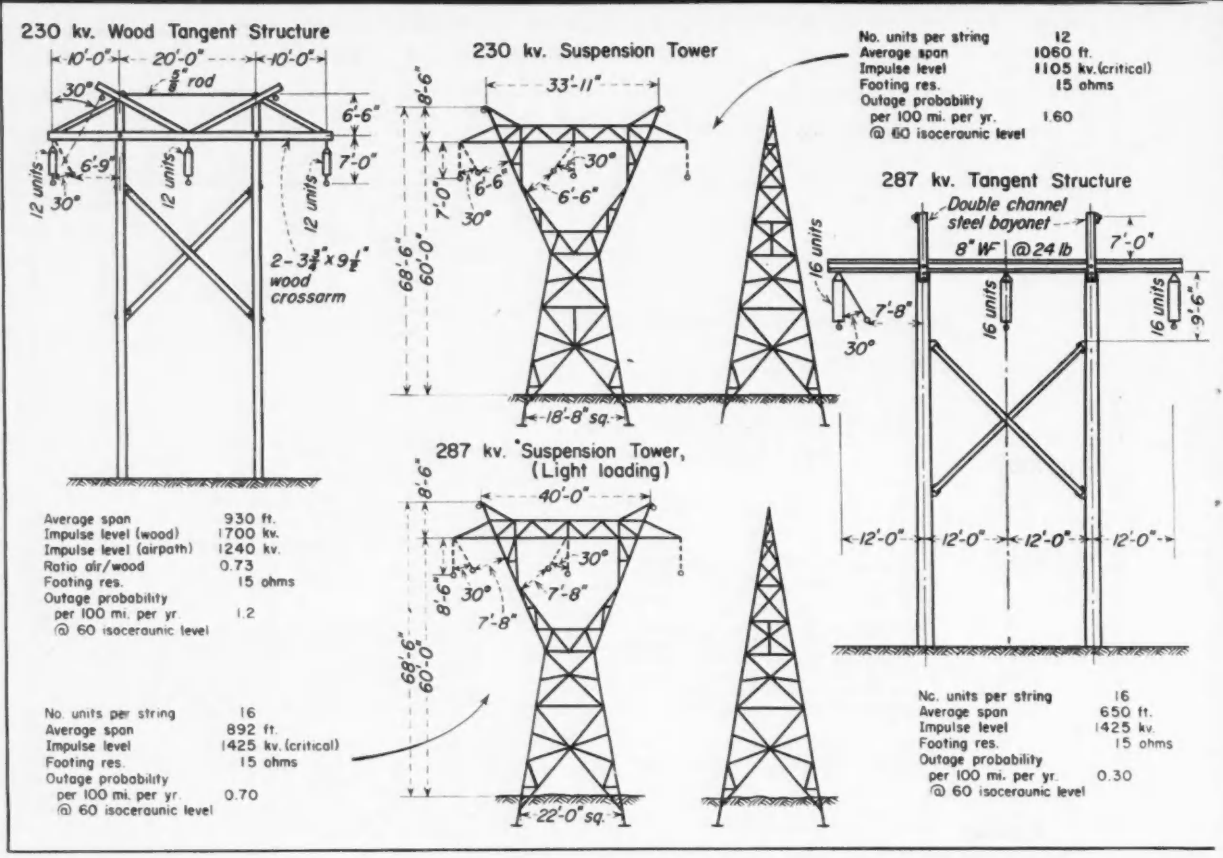
This conclusion is based on estimated values pertaining to the area served by Alabama Power. The fact that the company's service area is situated in the heart of the pine producing country weights material estimates heavily in favor of wood.

Although the figures in the study represent a local solution to the structural problem of high voltage transmission lines, the general method of attacking the problem should be applicable to all localities. However, some further qualification of the Alabama Power figures is necessary:

- The company has its own construction department and is not dependent on contractors. Labor costs were computed by this internal department.
- Compared to the country at large, loading conditions in Alabama are light. There are no heavy snow or sleet problems.
- None of the studies covered lines in the hurricane zone, a relatively small proportion of the company's total area.

Economy Is Objective . . . The purpose of the studies was to design transmission lines for a higher voltage primary network than the 110-kv system in present operation. From these lines would be determined the cost of a typical mile of each voltage using various conductor sizes. Three basic voltages were decided upon for study: 230 kv, 287 kv, and 330 kv.

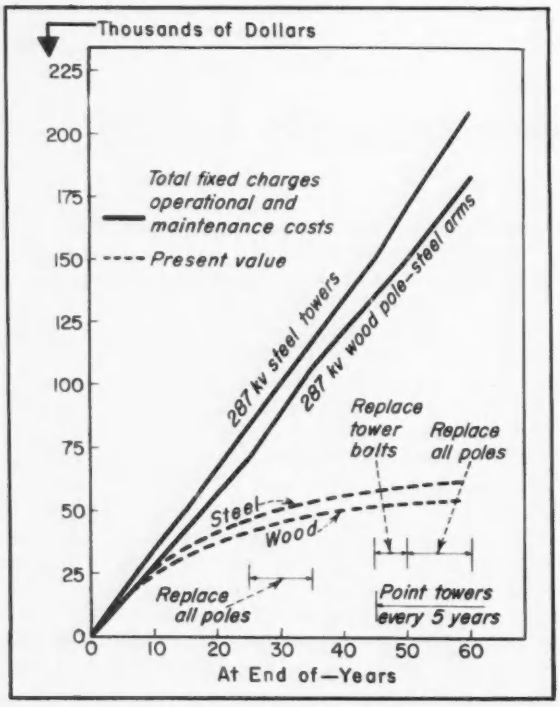
Conductor Selection . . . The first step was to choose mini-



STANDARD 230-KV LINES pose few problems with wood structures like this. Typical mile is estimated at $18,273 while . . .

STEEL TOWER (above) adds $6,500 to cost at 230-kv. Light-loading tower (below) is desirable for 287 kv but expensive . . .

GOOD COMPROMISE for 287 kv is wood-pole steel-arm structure saving $5,000 per mile. Steel top gains height, stops pole burning



COMBINATION WOOD AND STEEL structures prove cheaper on long term basis. Both types of towers use identical conductors

mum size and spacing of conductors to remain in a desirable corona loss and radio interference range:

	230 kv	287 kv	330 kv
Minimum diameter	1 in.	1.4 in.	1.6 in.
Minimum spacing	20 ft.	24 ft.	28 ft.

Multiple conductors were not given detailed consideration in the study because they presented too many unknowns. Some of the puzzles included magnetic attraction, vibration, bridging of bundle by ice, method of yoking conductors, and fittings. Finally, these conductors were chosen:

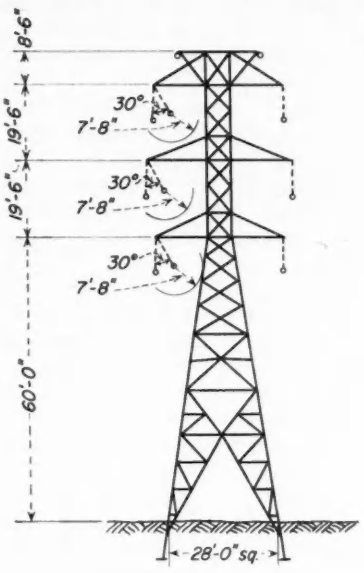
230 kv	287 kv	330 kv
795,000 ACSR	1,351,000 ACSR	1,275,000 Expanded ACSR
1,113,000 ACSR	1,510,500 All Aluminum	
1,351,000 ACSR		

Protection for these conductors was specified as armor rods for shorter spans and vibration dampers for longer spans and dead ends. Compression dead ends were to be used.

Insulation Level . . . One method of computing insulation level consists of developing working factors for various abnormal conditions. These are based on 60-cycle flashover and switching surges.

A basically similar method involves computing the necessary wet flashover insulation. It uses all factors except insulator contamination and age and omits the desired safety factor. Even without these figures in the computation, the method provides a safety factor of 2.4, a result

287 kv. Transmission Line Tower, Double Circuit



No. units per string	16
Average span	1040 ft.
Impulse level	1425 kv. (critical)
Footing res.	15 ohms
Outage probability per 100 mi. per yr. @ 60 isoceraunic level	0.80

DOUBLE CIRCUIT STEEL TOWER for 287 kv with one or both circuits in place was included for comparison with single circuit construction. Line cost approximates $53,000 per mile

which is satisfactory to Alabama Power because it compensates for contamination and age that may be encountered.

Using the second method, it was decided that if the wet flashover value of the 287 kv and 330 kv could be met, then adequate switching surge insulation and high impulse level would produce a satisfactorily performing line.

On the 230-kv line, considerable benefit would result from the use of wood's lower insulation level and higher estimated performance. Some of the higher voltage lines use wood poles and steel arms. Insulation factors for such combinations were computed as for steel structures. These were the insulation levels:

	230 kv		287 kv		330 kv	
	Wood	Steel	Wood	Steel	Wood	Steel
Units	11	12	15	16	17	18

Grading rings were not considered necessary on the 230-kv line, although they were definitely a requirement on the 330-kv line. In the mid-range, the 287-kv line would be operating close to the point where grading rings or special clamps might be needed. Arrangements were made to add them later if performance required them.

All of the designs in the study were based on conductor-to-tower air gap insulation at 30-deg swing being equal in impulse value to the insulator swing. This factor is applicable to all lines using steel crossarms or towers.

On lines using wood arms the impulse value of the air gap at 30 deg swing is approximately 75% of the insulator string plus crossarm. A flashover would not pass through wood but would go between conductor and pole ground.

Ground Problems . . . In Alabama Power's service area, there has been little difficulty in reducing footing resistance to 15 ohms by using counterpoise or sectional ground rods. Although present installations are mostly counterpoise, ground rods will get greater use on the new high voltage installations. It was considered impractical to reduce footing resistance below 15 ohms because the greatly increased cost offsets the benefits to be derived.

There was no necessity for increasing the size of the overhead ground wire which had already proven practical on the company's 110-kv system. This wire is ⅜-in., high-strength, galvanized steel strand. Its sag provides maximum mid-span clearance even with the larger conductors intended for the higher voltage lines. It also has the desired low tension for wood lines.

Loading Conditions . . . Construction of lines in Alabama Power's service area is based on three assumed loading conditions:

Medium Loading—8-lb wind, ¼-in. ice, 15 deg F.

Light Loading—12-lb wind, no ice, 30 deg F.

Hurricane Loading—30-lb wind, no ice, 32 deg F.

Medium loading zone conditions are heavier than present NESC because recorded wind velocities in this service area are fairly high. No studies were made of lines in the hurricane loading zone because a line in this small area would not be typical.

Suspension towers for the study were designed to NESC loadings with simultaneous application vertical and transverse loads at 2200 lb longitudinal per conductor. Wood structures were designed with a safety factor of 2 for vertical and transverse loads. Longitudinal loading was considered as zero.

A broken conductor was accepted as a calculated risk, but the inherent longitudinal strength in the tower was utilized wherever possible. Thus, the 2200-lb longitudinal loading is no more than the strength that can be developed by the lower part of the tower. In wood structures there is not enough longitudinal strength to remain intact if a conductor breaks.

Expected Performance . . . The expected performance of each of these lines was obtained from E. L. Harder and J. M. Clayton's curves. As a basis of comparison the permissible lightning current for a stroke to tower for several of these lines was figured from Bewley's formula and compared to the curves and to actual results obtained from one of the existing 110-kv lines, which is 150 miles long and considered typical. (See Table I).

Best performance seems to be promised by the 287-kv wood pole-steel arm line using all aluminum conductor. Short spans and large mid-span separation may account for this result. All expected performance values were estimated at an isoceraunic level of 60.

Basis For Estimates . . . Although the designs used to illustrate this article are not actually complete, the details of the structures were sufficient to permit actual cost estimates. Here is how the basic data were developed for the estimates:

1. The total number of structures per mile was deter-

mined by spotting structures on available line profiles considered typical of the area to be traversed. Usually a 20-mile section was used.

2. The number of angles per mile was an average of several surveys through the area considered.
3. The number of crossings over highways, rivers and railroads was determined by drawing probable line routes on state maps.
4. The lines were considered dead ended at the ends of 40-mile sections.
5. No line switches were included.
6. No transpositions were included.
7. Guys were ⅜-in. high strength, galvanized steel wire using double strands where required. Anchors were concrete ball explosive type.
8. No wood strain insulators were considered.
9. Rights of way acquisition costs were not included. Clearing costs included clearing a 100-ft wide strip and danger trees.

In the medium loading zone, a typical mile of transmission line would have the following characteristics:

1. .720 angles per mile—.362 over 10 deg.
2. .125 railroad crossings per mile
3. .125 highway crossings per mile
4. .0125 navigable river crossings per mile.
5. .04 dead ends per mile.

In the light loading zone, a typical mile of transmission line would have the same characteristics except that there would be .452 angles per mile—.10 would be over 10 deg.

Results Considered . . . Design similarities for 230 and 287-kv steel tower lines of equal conductor reduced cost differences between the lines to $522 (Table II). Expanded conductor on the 330-kv lines gave greater loadings in proportion to the circular mil size of the conductor. Therefore, the cost for 330 kv seems high when conductor sizes are compared.

There was an attempt to substitute steel poles for wood poles on the 287 and 330-kv lines, but the cost was much higher than for conventional towers. Swedish type welded poles were also considered, but the cost of the footing was so high that it offset the steel savings.

Long term differences in costs between lines of wood pole and steel construction using identical conductors were estimated from previous experience. The curves were based on these assumptions:

- Replacement of all poles and wood arms between the 25th and 35th year, and between the 50th and 60th year. After 60 years all poles will have been changed twice.
- Replacement of all tower bolts between the 45th and 50th year.
- Painting of the towers every five years after the 45th year to compensate for the worn galvanizing.

Table I—Expected performance of lines compared with expense

	Harder & Clayton's Curves		Bewley's Formula
	Estimated Performance	Maximum Stroke to Tower	Maximum Stroke to Mid-Span	Maximum Stroke to Tower
110-kv line (Actual) Performance .67)	1.5	98,000	105,000	89,000
230 kv—Wood Poles—Wood Arms (Fig. 3)	1.2	121,000	105,000	117,000
230 kv—Steel Towers (Fig. 4)	1.6	102,000	102,000	102,000
287 kv—Wood Poles—Steel Arms (Fig. 5)	0.3	145,000	143,000	136,000
287 kv—Steel Towers (Fig. 6)	0.7	130,000	98,000	135,000
330 kv—Wood Poles—Steel Arms	0.5	160,000	112,000	143,000
330 kv—Steel Towers	0.4	152,000	118,000	141,000

Table II—Cost comparison of lines studied

Voltage	No. Cct.	Type Construction	Conductor Size—Cir Mil	Grading Shields	Loading Zone	Estimated Cost/ Typical Miles
230 kv	1	Wood	795,000 ACSR	No	Medium	$18,273
230 kv	1	Steel Towers	795,000 ACSR	No	Medium	24,793
230 kv	1	Steel Towers	1,113,000 ACSR	No	Medium	27,848
230 kv	1	Steel Towers	1,351,000 ACSR	No	Medium	29,173
287 kv	1	Wood Poles—Steel Arms	1,510,500 Al.	No	Light	23,878
287 kv	1	Wood Poles—Steel Arms	1,510,500 Al.	No	Medium	26,171
287 kv	1	Steel Towers	1,351,500 ACSR	No	Medium	29,695
287 kv	1	Steel Towers	1,510,500 Al.	No	Medium	31,123
287 kv	1	Steel Towers	1,510,500 Al.	No	Light	28,241
287 kv	2	Steel Towers	1,351,500 ACSR	No	Medium	52,851
287 kv	2	Steel Towers	1,510,500 Al.	No	Medium	53,978
287 kv	1	Wood Poles—Wood Arms	1,510,500 Al.	No	Light	25,848
330 kv	1	Wood Poles—Steel Arms	1,275,000 Expanded ACSR	Yes	Medium	31,28[illegible]
330 kv	1	Steel Towers	1,275,000 Expanded ACSR	Yes	Medium	36,54[illegible]

Table III—Cost of typical mile 287-kv transmission line—wood poles, steel arms, 1,510,500 cir mil all aluminum, light loading

Item	Quantity	Material Cost	Labor Cost	Total
Survey	All	$ 3.00	$ 204.00	
Clearing	——	——	600.00	
Structures and towers:				
Wood, Tangent	6.383	4,099.67		
Wood, Tangent Railroad Crossing	.250	180.67		
Wood, Tangent Highway Crossing	.250	180.67		
Wood, Angle (0 deg-10 deg)	.352	322.42		
Wood, Angle (10 deg Up)	.100	31.10		
Wood, Dead End	.040	38.16		
Steel, Navigable River Crossing	0.25	250.00		
Poles:				
75 ft, Class 2	.800	143.40		
70 ft, Class 1	.540	95.24		
70 ft, Class 3	.360	46.40		
65 ft, Class 1	.300	45.01		
65 ft, Class 2	4.436	568.87		
65 ft, Class 3	8.266	906.61		
60 ft, Class 3	.540	50.20		
Total	15.242	$ 6,958.42	1,730.00	
Conductor and Accessories:				
1,510,500 cir mil All Aluminum	23,127 lb.	7,308.13		
Armor Rods	22.08	237.14		
Armor Rod Clamps	44.16	72.86		
Dampers, Conductor	1.74	18.79		
Groundwire and Accessories:				
⅜-in. 7-Strand H.S. Steel	2,968 lb.	474.88		
Armor Rods	14.67	12.91		
Groundwire Dampers	1.16	3.71		
Counterpoise, Zinc	666 lb.	199.80		
Copperweld Groundrods	.457	8.17		
Total		$ 8,336.39	$1,545.00	
Total All Material and Labor		$15,297.81	$4,139.00	
Plus 8% Miscellaneous Material		1,223.82	——	
Transportation, Meals, Etc.		1,448.65	——	
Totals		$17,970.28	$4,139.00	$22,109.28
Engineering and Overhead				1,768.74
TOTAL ESTIMATED COST PER MILE				$23,878.02

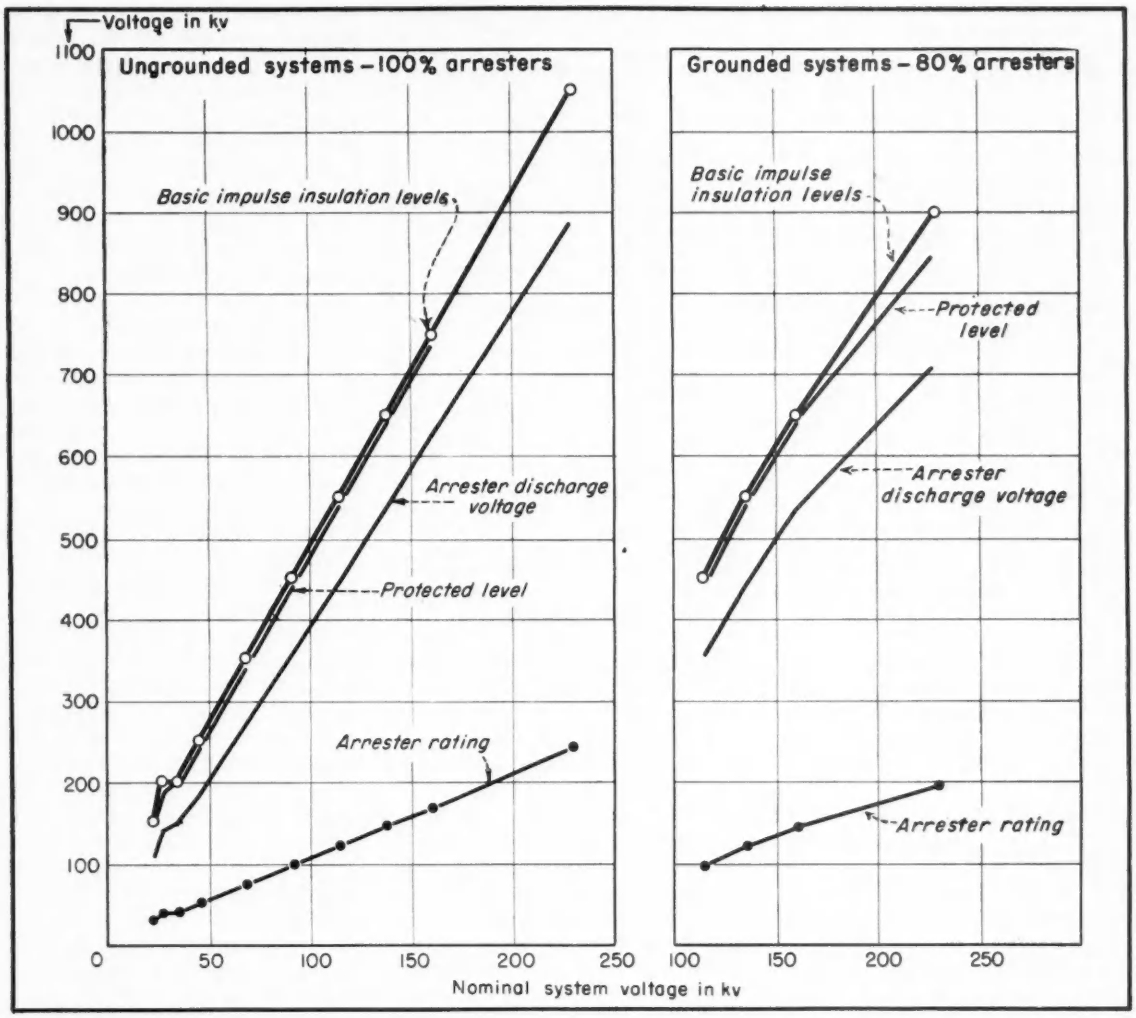


FIG 1—MARGIN OF PROTECTION FOR TODAY'S BIL's is established from lightning protection and tests. Bottom curve shows arrester rating. Next curve represents arrester voltage for 5,000-amp 10 x 20 μsec discharge, including +10% manufacturing tolerance. Adding a margin of 15% discharge voltage +30 kv gives the protected level which almost coincides with accepted BIL's for these voltages

In Modern Transmission Design . . .

Probabilities Set Insulation Levels

Operating experience with coordinated lightning protection for lower voltage guides selections of BILs for EHV systems

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Coordination of insulation and the determination of basic impulse insulation levels for transmission systems must be approached on a rational and economical basis. Insulation should be kept as low as possible commensurate with the ability to protect it.

One approach is to consider the worst theoretical case, one in which all of the unfavorable factors are permitted to pyramid. Such possibilities are involved as:

1. An unusually severe arrester discharge current.

2. Considerable separation between arrestor and protected equipment.

3. An arrester discharge voltage at the maximum value permitted by the manufacturer's tolerances.

4. No margin over specified impulse strength of protected equipment.

Simultaneous occurrence of all these pessimistic factors would lead either to higher insulation levels than those now in use or to more elaborate protective systems. Good engineering dictates consideration of the **probability** of all these factors. While pyramiding of all unfavorable factors might be possible, it is unlikely. The problem is to seek a satisfactory and economical compromise.

Each factor might be analyzed independently with regard to its magnitude and the probability of occurrence of each magnitude. Then a magni-

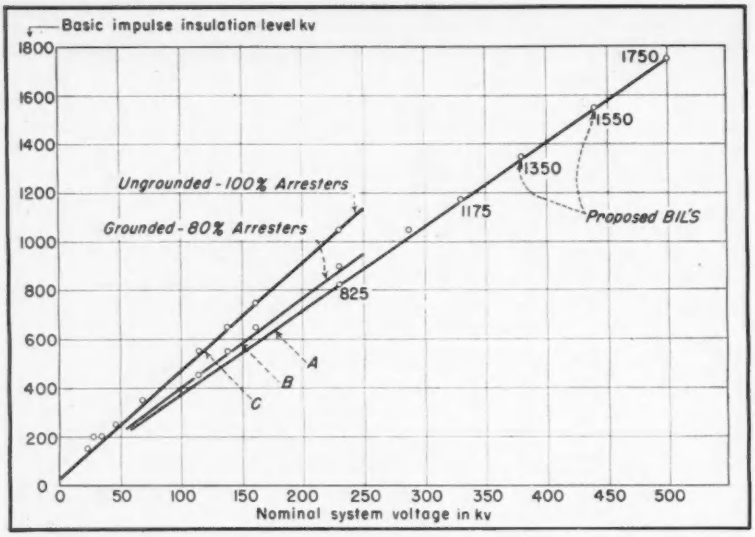


FIG 2—PROPOSED BIL's FOR EHV SYSTEMS provide a protective margin with 75% arresters similar to present practice at lower voltages. But conventional 80% arresters encroach upon the margin. Special 80% arresters with less tolerance also are satisfactory

tude might be selected whose frequency of occurrence appears reasonable. This is difficult because in many cases there are insufficient data and because of interrelation of factors.

Experience Provides Guide . . . Fortunately the operating experience obtained with transformers protected with arresters according to good modern practice provides another approach. This course has the advantage that **all** factors have been taken into account, those that are evident and can be analyzed as well as those of a more intangible character. There are just enough failures to indicate that present methods of applying arresters are reasonable.

Setting insulation levels in the first place, or the converse problem of choosing an insulation level from those already established, involves three major steps:

1. Establish arrester rating by determining the maximum voltage to ground on a sound phase at the arrester location during fault conditions. This does not involve probability.

2. Assume arrester discharge conditions. This depends on many factors and involves a large measure of probability. These assumptions determine arrester discharge voltage.

3. Add a certain margin over and above the arrester discharge voltage to determine the "protected level". This provides for such factors as departures from assumed discharge currents in the arrester, separation between lightning arrester and protected equipment, and manufacturing tolerances of arresters.

These steps are illustrated in Fig. 1 for several voltage levels. For ungrounded systems, the lightning arrester rating was taken as the maximum voltage in the tolerable zone, or the next higher standard rating. In most cases it is 105% of the nominal system voltage. For the grounded case, the rating was taken as approximately 80% that of the corresponding ungrounded system. Crest voltage across the arrester when discharging a 5,000-amp 10 x 20 μsec wave is shown with the +10% tolerance reported by manufacturers of station-type arresters. A margin was added to this arrester discharge voltage so that the final computed values would fall just below the corresponding BIL's in common use for these system voltages. Formula for margin to fit the curves is 15% of arrester crest voltage plus a constant 30 kv.

There is very close correspondence between the protected level so computed and the corresponding BIL. Arresters applied according to these values have given excellent performance both as to failures of arresters and as to protection afforded to the protected equipment. This combination of arrester discharge current and margin is one of several possible combinations that give good results.

Propose BIL's for EHV . . . Standardizing bodies in the United States have under consideration BIL's for systems above 287.5 kv. It is basic to this work that the maximum system voltages in the tolerable zone be 5% higher than the nominal system voltages. The uppermost curve of Fig 2 shows BIL's for systems utilizing 100% arresters. Below this are plotted the BIL's, one class lower, that are used on grounded-neutral systems with 80% arresters.

BIL's are plotted against the corresponding nominal system voltages for 287.5 kv, 330 kv, 380 kv, 440 kv, and 500 kv. The last four values are those now being considered for standardization. If coordination at these BIL values is based on a 5,000-amp, 10x20 μsec discharge through the arrester and on the maximum tolerance in arrester characteristic, then the resultant margin with a 75% arrester +10% tolerance is 19% +30 kv. If, on the other hand, a 10,000-amp discharge is assumed, the margin would be reduced to 10% +30 kv, as shown by Table I. Where system grounding conditions are such that an 80% arrester must be used, the margin with standard characteristics becomes rather low, 11.5% +30 kv for 5,000 amp, or 3% +30 kv for 10,000 amp.

Special 80% arresters are available in which the 10% manufacturing tolerance is eliminated. If such arresters are used, then the margins become 22.5% +30 kv and 13% +30 kv, respectively. But regardless of tolerance in the arrester or assumed discharge current, substantially the same coordination is obtained at the four upper points with 75% arresters as is obtained on 115-kv and 138-kv systems with 80% arresters.

Insulation Precludes Lower BIL's . . . The BIL's now assigned to systems of 287.5 kv and higher are so low that most insulation engineers fear that any further lowering of the impulse characteristics might endanger the life of equipment. While arresters can be built today which would protect equipment having lower BIL's than those indicated, advantage cannot be taken of their availability because of the hazards introduced under normal conditions and switching surges.

The risk involved in going to lower values of insulation is very great. Equipment in these higher voltages is usually associated with transmission lines carrying large blocks of power. A failure would not only be costly in

repairs but might hazard disuse of other important equipment. These BIL's in themselves already represent a reduction as compared to practice in the lower transmission voltages. Before further reductions are made, it would be well to await the results of operation with the present values. It is desirable to go slowly.

Field Measurements Show Surge Severity . . . Extensive field data obtained with magnetic links indicate that only 4% of discharges for station-type lightning arresters exceed 5,000 amp. The probability of such discharges for each lightning arrester is one every 14 years for 5,000 amp, and one every 58 years for 10,000. In most cases these records were obtained at locations regarded as severe, to provide data quickly; therefore they probably represent more severe duty than the average location.

One might argue that, because an arrester is a protective device, the most severe condition should be accepted. If this philosophy were followed, one would consider a 20,000-amp discharge—or even a 35,000-amp discharge as this is the maximum that has been recorded. But all of the most severe conditions must not be imposed simultaneously. A reasonable condition should be chosen and correlated with the actual overall service performance of arresters and protected equipments.

One might choose a 10,000-amp, 10 x 20 μsec wave to fix arrester performance. This gives a crest discharge voltage 8% higher than the 5,000-amp discharge. Then, other conditions remaining the same, the margin would have to be reduced from 15 to 6.5% to give the same protected level.

Other factors affect the discharge current in arresters. In a well-shielded substation or transmission line, 99.8 or 99.9% of all of the discharges will be diverted harmlessly to ground. Substations always have relatively low resistances, but the first and second tower out on the line might have high footing resistances. Thus a stroke to the shield wire on the first few spans might discharge a significant portion of the current through the arrester. The type of line construction, whether steel tower or wood poles, and the amount of insulation also affect the discharge current.

For 25 years the 10 x 20 μsec current wave has been used to determine the discharge characteristics of a lightning arrester. It represents approximately the most severe condition that can be obtained in laboratories without undue expense and effort. But it does not represent the most severe condition that can be encountered in practice.

Steeper Test Wave Not Justified . . . A discharge record that approximates 5,000-amp crest with a 5,000-amp rate of rise has been recorded. The crest discharge voltage with this type of wave is 17% greater than for a 10 x 20 current wave having a crest of 5,000 amp. But the crest value alone does not reflect the effect upon the insulation. And practical laboratory limitations make it difficult to obtain such a current wave with a long tail. A system with a ground wire might receive such a discharge in case of a direct stroke to the conductor when the shielding function fails or when the line insulation fails during an exceptionally severe stroke to the ground wire. But the **probability** must also be considered.

At least 80% of all transmission lines above 100 kv are either equipped with ground wires or have ground wires extending for a mile from each substation. It is this range of voltages in which significant economies result from reducing the insulation of transformers on effectively grounded systems. In 34.5 and 69-kv systems the use of ground wires is not so prevalent, but it is not customary to use reduced insulation even if the system is well grounded. It would appear, therefore, that for systems of 100 kv or greater the steep current discharge can be neglected. For substations on 34.5 and 69-kv grounded-neutral systems, the inherent margin is sufficiently great that this refinement need not be included.

Some substations are not provided with shield wires as the designers feel that the calculated risk of mechanical failure of the shield wire is greater than the protection afforded. Without shield wires the probability of steeper waves is somewhat greater than with shield wires. But the probability of a 5,000-amp rate of rise is not sufficient to justify its use as a basis for arrester application.

Arrester Voltage Resembles Test Wave . . . The voltage across an arrester when discharging a 10 x 20 μsec wave, approximates, but is not exactly the same as, the 1.5 x 40 μsec voltage wave used as a basis of insulation coordination and for testing the impulse characteristics of equipment. It has been argued that a current wave should be chosen that would give as close as possible a 1.5 x 40 μsec discharge voltage wave. A more theoretical approach would be to choose a reasonably severe wave that might occur in practice and then determine the actual shape of the voltage wave across the arrester. Then the volt-time characteristics of insulation could be determined with this type of voltage wave form applied. This would become rather involved, and the extra complication is not warranted.

In view of the little data available on the wave shape of arrester discharge currents, the wide variations in conditions of application, and the enormous amount of laboratory data

AS THE AUTHOR SEES IT

- **Arrester operating conditions and margins should not be viewed too strictly.**
- **All of the most severe operating conditions cannot be expected to occur simultaneously.**
- **Conditions vary so widely that one can only choose a reasonable combination, then set a margin so combination satisfies current applications proved satisfactory by experience.**
- **Emphasis should not be placed upon one particular extreme condition.**
- **It is not contended that particular phases of arrester applications should not be analyzed separately, as this constitutes the most fruitful means of adding to our understanding of the problem.**
- **The author prefers to use a 5,000-amp, 10 x 20-μsec discharge and include the full +10% manufacturing tolerance. To the crest value of arrester voltage so fixed should be added a 15% + 30-kv margin. This combination provides satisfactory coordination except for very special substation applications.**

Table I—Margins in Proposed EHV BIL's

Arrester Characteristics		Margin for 10 x 20-μsec Wave of	
Rating	Tolerance	5,000 Amp	10,000 Amp
75%	10%	19% + 30 kv	10% + 30 kv
80%	10%	11.5% + 30 kv	3% + 30 kv
80%	0%	22.5% + 30 kv	13% + 30kv
100%*	10%	15% + 30 kv	6.5% + 30 kv
80%*	10%	20% + 30 kv	11% + 30 kv

* Margins in 22-230-kv practice for comparison.

collected to date, it would be unwise to use any other than a 10 x 20 μsec current wave for coordination.

Separation Affects Voltage . . . The voltage across the lightning arrester may be considered (1) before breakdown and (2) during discharge. The voltage before breakdown rises at a rate determined by the incoming surge. Upon breakdown of the arrester gap, the current begins to discharge, and the voltage across the arrester becomes the discharge voltage. The voltage across the arrester equals the voltage across the protected equipment only when the arrester is immediately adjacent to it.

Determination of voltages within the substation structure depends upon such factors as length of downlead from the bus to the arrester, electrical distance horizontally between arrester and protected equipment, stub end feeds, and, even more important, the number of lines emanating from the substation. The conditions are so variable and complex that unless one makes a rather detailed study of the station, it becomes impossible to do otherwise than make a general allowance for these effects. Unless the arrester is located on the transformer case, it is well to include separation as one of the factors entering into the margin and to limit the separation to certain prescribed maximum distances.

Manufacturing Tolerance Applies . . . In the standards for lightning arresters, the crest value of the discharge voltages is given for different values of 10 x 20-μsec-current waves (5,000, 10,000 and 20,000-amp crest). These values represent the average of a large number of arresters. A tolerance of 10% above these average values is then provided. This represents the maximum voltage which must not be exceeded. In the probabilities of manufacture, 95% of the arresters test within a tolerance of 6-2/3% above the average value. It has been suggested that the probability factor in manufacture be recognized in the application of lightning arresters by using a value equal to 6-2/3% above the average. Thus, there exist three possible bases for coordination: the average value, a value 6-2/3% greater, or a value 10% greater.

In computing the discharge voltages of Fig. 1, the author preferred to use 10% higher than the average. This is largely a matter of judgment and preference. But whatever value be used, adjustment must be made in the margin so that the overall performance of the arrester characteristic and the margin remains the same.

Insulation Has Short-Time Margin . . . The major insulation of transformers withstands 3-μsec chopped waves about 15% in excess of the full-wave test value. For shorter times the insulation has even greater strength. This is fortunate as the voltage across insulation at points other than the arrester location has superposed oscillations of short duration. This overvoltage nests in with the upturn characteristic of insulation for short periods of application. This factor also tends to compensate for the peaking effect of arrester discharge voltage with high rates of rise in discharge current.

Although the insulation of the protected equipment is rated on a minimum basis, certain margins are involved in the variabilities of manufacture and the necessities of design. These margins exist with even more reason than the lightning arrester margins as the lightning arrester probability can be controlled by tests in the course of manufacture. The author is not proposing that this region be encroached upon, but is merely calling attention to the fact that it does exist for sound basic reasons.

It should be apparent that to choose the conditions of application from a consideration of each individual factor and the probabilities with which these factors occur becomes quite involved. But all the combinations in Table I show the same satisfactory coordination. The margins are based upon the characteristics of station-type arresters.

Line-type Arresters Cut Margin . . . Line-type arresters whose average discharge characteristics are 25% greater and have 15% tolerance also have given good service but not as uniformly good as station-type arresters. Using the higher average discharge voltage and incorporating the higher tolerance of line-type arresters, then the margin becomes —10% +30 kv to obtain the same protective level at 5,000 amp. This appears to reflect reasonably the somewhat inferior protection afforded by line-type arresters as compared to station-type arresters.

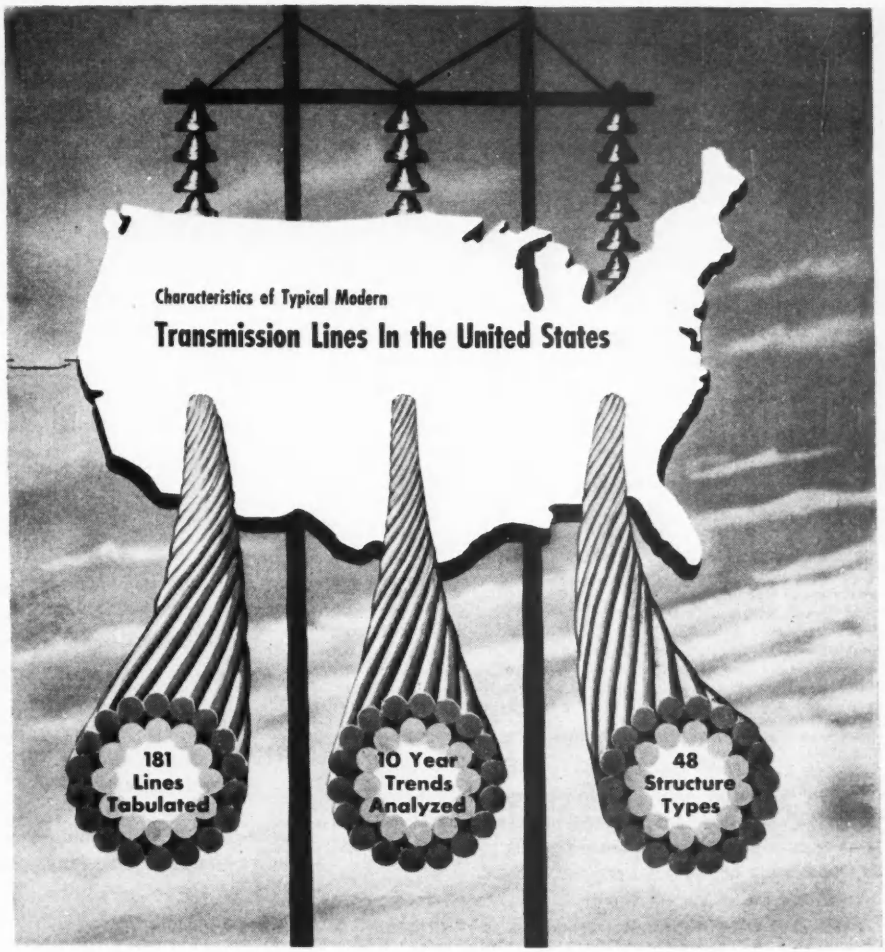
On distribution circuits the absence of the shield wires, particularly in rural applications, increases the exposure to the effects of lightning. This is substantiated by magnetic links which indicate that a higher arrester discharge current, on the order of 20,000 amp, should be used for this type of application. But because arresters in this voltage class are usually connected across the transformers, no margin need be included. The assumption of 20,000-amp discharge current and no margin appears to give protective values that reflect the service obtained from operating experience.

With this additional data as a back ground, 5,000 amp appears to be a reasonable compromise for shielded substation arrester discharge current. The maximum tolerance should be retained.

Table II—Arrester Characteristics and Margins for the Same Protection

Arrester Characteristics	Margin for 10 x 20-μsec Wave of	
	5,000 Amp	10,000 Amp
Average + 10% tolerance	15% + 30 kv	6.5% + 30 kv
Average + 6⅔% tolerance	18% + 30 kv	9.0% + 30 kv
Average + no tolerance	27% + 30 kv	17.5% + 30 kv

Survey of 87 Utilities and 181 lines over 100 kv shows how . . .


Characteristics of Typical Modern
Transmission Lines In the United States
181 Lines Tabulated
10 Year Trends Analyzed
48 Structure Types

Modern Transmission Designs Adapt Engineering Advances

Two hundred and eighty transmission lines ranging from 100 to 340 kv should afford a representative sampling of the lines of the U.S.A. Consequently, a compilation of their design details should afford an insight into the trends of design particularly if the data are confined to recently built lines.

This is what is presented in the ensuing pages as the lines reported are all of the last decade and therefore reflect the fruits of the preceding two decades of intensified study of lightning. Further, the lines are confined to voltages above 100 kv. To this extent the compilation differs from the equally comprehensive surveys published by Electrical World in 1927 and 1929. Those surveys included the lower voltages prevalent in that period. Many of the 66-kv lines have since become virtually subtransmission and correspondingly standardized in construction details.

Study of the itemized details will assuredly provide a cross-section of current practice, particularly when items about a particular line are associated with other relevant items about the same line. Failure to recognize these interrelated facts may lead to strange conclusions. Nevertheless, there is a certain amount of value from a statistical study of the tabulated information. This is reflected in the small tables that are "lift-outs" from the large tables.

Structure designs show 48 distinct variations. These are diagrammed on p. 150 and referenced in the respective columns of line characteristics.

From these condensed compilations a limited number of inferences may be drawn. These are merely indexes of mass practice and in no sense intended to be a guide to design. For these summary tables and their interpretation **—turn the page.**

Summary Shows Preference for Wood Structures . . .

Structural Material Used in Transmission—Lines or Parts of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Wood	105	88	14	5	0	0
Steel	19	54	3	22	2	2

Wood is the preferred structural material at 5 to 1 for both 115 kv and 161 kv and 1½ to 1 for 138 kv. Steel is preferred 4 to 1 for 220 kv and exclusively above

Types of Cross Arms and Pole Bracing—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Wood Arms on Wood Poles	96	75	13	5	0	0
Wood Arms on Steel Towers	0	6	0	0	0	0
Steel Arms on Wood Poles	7	0	0	0	0	0
Steel Arms on Steel Towers	22	39	3	19	1	1
Spar. Arms	6	2	0	0	0	0
Double Plank	1	0	1	0	0	0
Wishbone	2	0	0	0	0	0
Pole Bracing Wood	63	57	13	5	0	0
Poles Guyed	3	2	0	4	0	0

Wood crossarms are the rule—except for 1 out of 12 of the 138-kv lines—for all wood structures up to 230 kv. Steel arms are not uncommon on wood poles, for 115 kv, or wood arms on steel towers for 138 kv.

Steel crossarms outnumber wood on steel structures at all voltages. In fact, they are exclusive except for a few 138-kv lines that have wood arms.

Spar and double plank crossarms have been used on 115 kv, 138 kv, and 161 kv, and there are indications that spar arms have increased somewhat in popularity.

Range of Phase Separation (Ft) vs Conductor Configuration

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Horizontal, Aver	13.66	14.7	16	25.23	30	.....
Max, Min	16-10.5	12-12	20.7-13.5	33.33-19.25	32.5-27.5	.....
Vertical, Aver	11.04	14.1	14.5	18.56	....	21.5
Max-Min	13.5-9	20-10	14.5-14.5	24.5-14.25	....	21.5-21.5
Triangular, Aver	11.53	14.5	....	....	....	.....
Max-Min	14-10	26-10	....	....	....	.....

Horizontal separation of phase wires ranges from an average of 13.66 ft for 115 kv to 30 ft for 330 kv.

Vertical separation of phase wires is somewhat less than is used for horizontal separation but increases similarly with voltage (average 11 ft for 115 kv to 21.5 ft for 330).

Triangular configuration of conductors was not shown for voltages above 150 kv; the customary conductor separation is 11.5 ft for 115 kv and 14.5 for 138 kv.

Configuration of Phase Conductors—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Horizontal	94	78	16	19	2	1
Vertical (aligned)	19	11	0	2	0	0
Vertical (offset)	17	30	1	6	0	1
Triangular	5	4	0	0	0	0

Horizontal conductor arrangement is the indicated favorite for 60 to 70% of the lines 100-250 kv. At higher voltages it is a 3/0 preference for single-circuit lines.

Conductor Offset from Vertical Configuration—Ft

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Aver	3.21	4.1	2.5	4.2	....	5.0
Max	8	8.5	2.5	8.0	....	5.0
Min	0.25	2.5	2.5	3.0	....	5.0
Min	0.25	2.5	2.5	3.0	....	5.0

Offset of middle conductors is indicated for 60% of the vertical configurations, presumably to contend with galloping conductors.

Offset of middle conductor from vertical alignment increases to a 5-ft value at 330 kv.

Range of Minimum Clearance to Structure—Ft (Max, Aver, Min)

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Horizontal	8-5.38-2	7.7-5.1-2.7	7.5-4.5-3	20-8.2-4	11-8.5-6	.....
Vertical	8-4.85-2.5	10-5.2-3	7-7-7	9-6.5-5	.....	7.75-7.75-7.75
Triangular	5.16-3.3-2.25	10-6.1-4.5	.....	.....	.....	.....

Minimum clearance of conductors to structure is practically the same for horizontal, vertical, or triangular construction and, quite naturally, increases with voltage.

Range of Minimum Clearance to Terrain—Ft (Max, Aver, Min)

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Horizontal	40-26.13-22	31-27-23	32-28-25	35-30.7-27	32.4-29.7-27	.....
Vertical	40-30.9-23	48-30-25	30-30-30	37-30.6-25	.....	35-35-35
Triangular	55-39.8-26	31-30-27.5	.....	.....	.....	.....

ACSR Conductors . . . and Steel Ground Wires

Line Conductor Type and Material—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Copper	28	17	5	1	1	0
Copper (High Temp)	5	2	0	0	0	0
ACSR	79	91	13	26	1	1
Copperweld	5	5	0	0	0	0
Copperweld-Copper	4	3	0	1	0	0
Aluminum	0	2	0	0	0	0
Steel	0	0	0	0	0	0

Aluminum (ACSR) outnumbers all other conductors combined in number of lines at any voltage between 100 to 350 kv except 289-kv. Scarcity of copper during recent expansion period undoubtedly explains much of the dominance of aluminum.

Copper with high temperature characteristics was reported for 1 in 7 of the lines, 100-200 kv, where copper was chosen; Copperweld or Copperweld-copper for 1 in 3.

Aluminum (not ACSR) was reported as used for only two lines, and these were 138 kv.

Type Armor Used at Conductor Clamps—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
None	42	29	2	0	1	0
Rods	19	13	1	4	0	1
Tapered Rods	26	42	10	19	1	0
Preformed	10	19	2	3	0	0
Alum. Liners	5	2	0	0	0	0
Copper Liners	1	0	0	0	0	0
H.D. Copper	1	0	0	0	0	0
Bronze	1	0	0	0	0	0

Consonant with predominant use of aluminum conductors is the indicated preference—1½ to 1 for 115 kv, 3 to 1 for 138 kv and 6/1 for 161 kv—for some form of protective armoring at clamps.

Choice of rods of some form outnumbers "no armor" on a 3½ to 1 basis.

Type of Vibration Dampers Used—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Stockbridge	29	39	8	15	2	1
Alcoa	.....	6	0	0	0	0
Rods	2	0	0	1	0	0
None	75	49	6	9	0	0

Vibration dampers of some type are reported for 45% of the lines. Stockbridge units outnumber other designs 10 to 1.

Number of Ground Wires Used—No. of Lines

Kv	100-130			131-150			151-200			201-250			251-300			301-400		
Number...	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2
NE	0	3	18	0	0	0	..	..	..	0	0	1	..	..	..	..	..	..
MA	0	2	11	0	0	7	..	..	..	0	0	5	..	..	..	..	..	..
ENC	0	2	2	0	13	34	..	..	..	0	0	3	..	..	..	..	..	..
WNC	0	0	11	0	3	2	0	0	9	0	0	2	..	..	..	..	..	..
SA	0	1	20	0	1	19	0	0	2	0	0	2	..	..	..	0	1	0
ESC	0	0	18	0	6	23	0	0	4	..	..	..	..	..	..	..	..	..
WSC	0	2	11	0	5	19	..	..	..	..	..	..	..	..	..	..	..	..
Mtn	2	1	2	0	2	5	2	0	1	1	0	2	..	..	..	..	..	..
Pac	11	2	2*	0	0	2	..	..	..	2	3	6	0	0	2	0	0	0
USA	**13**	**13**	**95**	**0**	**30**	**111**	**2**	**0**	**16**	**3**	**3**	**21**	**0**	**0**	**2**	**0**	**1**	**0**

* Near terminals only

Two ground wires are indicated for five times as many lines as is one ground wire and 15 times as many as for none. Omission of ground wires predominates in the western states.

Overhead Ground Wire Material Used—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
HS Steel	70	49	12	19	2	0
Copperweld	28	15	0	1	0	0
EHS Copperweld	7	14	0	2	0	0
ACSR	2	28	0	1	0	1
Iron	3	0	0	0	0	0
Bronze	0	1	0	0	0	0

Overhead ground wire is steel on 60% of the lines, Copperweld on 25%, and ACSR on 12%. Other materials were reported only below 150 kv.

Range of Cone Angle of Protection—Degrees: Min, Aver, Max

Kv	100-130	131-150	151-200	201-250	251-300	301-400
NE	29; 34; 45	.....	.....	9; 9; 9	.....	.....
MA	27; 36; 48	9; 20; 30	.....	16; 26; 37	.....	.....
ENC	30; 36.5; 43	9; 29; 45	.....	5; 18; 36	.....	.....
WNC	25; 32; 36	11; 26; 30	30; 32.8; 38.5	17; 31.6; 39.5	.....	.....
SA	25; 29; 50	6; 27; 80	32; 32; 32	17; 17.3; 17.6	.....	33; 33; 33
ESC	10; 40; 80	30	20; 25; 30	.....	.....	.....
WSC	18; 30; 34.5	27; 31.5; 54	.....	.....	.....	.....
Mtn	30; 37; 45	27; 36; 45	45; 45; 45	5; 12.5; 20	.....	.....
Pac	30; 33; 41	.....	.....	16.6; 32; 42	13.4; 16.7; 20	.....

Note: Table ignores lines with zero angle for vertical configuration.

Even the average value of cone angle of protection varies widely—from 9 to 40 deg—but the general average is practically 30 deg.

BIL's Feature Insulation Design . . .

Counterpoise Practice—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Linear	23	4	0	6	1	0
Crowfoot	19	7	2	6	1	1
Linear & Crowfcot	2	0	0	2	0	0
Pole Grounds	4	0	0	....	....	0
None	48	77	13	11	0	1

No counterpoise is used on two thirds of the lines. Where counterpoise is used, it appears as often in linear form as in crowfoot pattern.

Arcing Horns, Range in Values—Min, Aver, Max

Kv	100-130	131-150	151-200	201-250	251-300	301-400
No Arcing Horn	56	39	4	5	2	1
Gap-in	18; 26; 44	10; 35; 63	26; 36; 42	38; 46; 80.5	38; 76; 119.5	60; 60; 60
None reported	44	46	13	23	0	1

Arcing horn gaps range from 26 in. average for 115 kv to 76 in. for 287 kv—with 60 in. for 340 kv.

Arcing horns are not used—107 cases—or not reported—127 cases—on about 83% of the lines.

Arcing Ring Diameters

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Rings not used	58	54	9	16	1	0
Top diam-in	.....	2 of 30; 1 of 24	5 of 33	1 of 36	.....	.....
Bottom diam-in	3 of 18x30	2 of 30; 1 Of 24	0	1 of 36	.....	.....
None repoited	.....	53	8	11	1	2

Arcing rings are not used—138 cases—or not reported 133 cases—on 95% of the lines.

Basic Line Impulse Insulation Level—Kv

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Wood Max	2,300	1,650	1,500	2,170	.....	.....
Aver	1,039	970	1,337	1,648	.....	.....
Min	485	550	1,000	1,100	.....	.....
Steel Max	1,105	1,900	750	1,585	1,870	1,665
Aver	613	655	750	1,347	1,648	1,625
Min	550	350	750	945	1,425	1,585

Note: Some items are for critical flashover, some for critical positive flashover, and a few only for guyed structures.

Basic impulse insulation level, ignoring isoceraunic variations, is consistently 7 to 9 times working voltage for wood lines and 4 to 6 times for steel on the average.

Expulsion Tube Gap—Inches

Line Kv	100-130	131-150	151-200	201-250	251-300	301-400
Exp Gap-in	11 and 13	..	121	..	..	..
None used	61	61	9	16	1	1
None reported	55	48	7	12	1	1

Expulsion tubes are either not used—149 cases—or not reported—124 cases—on more than 95% of the lines.

Arrester Rating Kv Range—Min, Aver, Max

Line Kv	100-130	131-150	151-200	201-250	251-300	301-400
Arrester Kv	92; 101; 122	109; 119; 157	145; 147; 169	185; 198; 230	182; 212; 242	264; 264.5; 265

Note: Substation arresters rated higher than those for generating station termination.

Range of arrester kv ratings for each voltage bracket is relatively narrow. The average is 87% of the line voltage for 100 to 250 kv, 74% for 289 kv, and 78% for 340 kv.

Basic Impulse Insulation Level of Terminal Apparatus—Kv (No. of Lines in parenthesis)

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Wood	450(5), 550(84) 650(43), 750(16) 865(1), 1,050(1)	350(3), 550(6) 750(3), 865(11)	560(1), 650(9)	900(3), 1,050(1)	.....	.....
Towers	550(13)	350(1), 550(12) 650(17) 750(1)	750(3)	825(2), 850(1) 900(7) 1,050(5)	900(1) 1,300(1)	1175(2)

BIL for terminal apparatus is: (1) Sensibly the same ratio to working voltage for wood and steel lines, (2) about 60% of line BIL for wood and 90% for steel. This margin decreases with voltage.

Neutral Grounding Types—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Solid	110	101	14	26	1.5	1
Resistance	0	0	0	0	0	0
Reactance	0	1	3	0	0.5	0
Dist. Transf	3	1	2	0	0	0
Petersen Coil	1	0	0	0	0	0
Isolated Neut	0	1	0	0	0	0
None	1	0	0	0	0	0

and Fast Clearing Controls Fault Damage

Solid grounding of neutrals is the reported practice on 95% of the lines; grounding through a distribution-type transformer and through reactance have a few adherents. Only one case of isolated neutral operation (138 kv) was reported.

Breaker Interruption—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
1½ cycles	3	0	0	0	0	0
3	2	6	6	15	2	2
4	0	11	0	0	0	0
5	76	50	11	9	0	0
6	2	4	0	1	0	0
7	2	1	0	0	0	0
8	15	30	0	1	0	0
12	1	0	0	0	0	0
15	.....	2	0	0	0	0
16	.....	1	0	0	0	0
20	1	0	0	0	0	0
Aver cycles	**5.57**	**6.2**	**4.3**	**4.0**	**3.0**	**3.0**

More of the lines from 100 to 200 kv use 5-cycle breaker interruption than any other value. At voltages above 200 kv a 3-cycle value is the general practice.

Communication Systems—No. of Lines

Kv	100-130	131-150	151-200	201-250	251-300	301-400
Telephone on Structures	1	0	0	0	0	0
None	64	60	12	14	1	1
None Reported	54	51	6	14	1	1
Pilot Wires	5	2	3	1	0	0
None	58	49	8	14	0	0
None Reported	55	36	6	13	1	2
Carrier 30-75 kc	23	24	6	8	0	1
76-100	14	10	1	6	1	1
100-150	21	10	1	14	1	1
150-215	5	1	0	7	0	1
50-150	13	15	3	18	2	1
50-200	1	4	6	19	2	1
No carrier	58	39	0	8	0	1
None reported	..	45	1	..	..	..
Microwave 960 mc	1	1	1	0	0	0
1860; 1940	1	0	5	4	0	0
6800; 7100	0	2	0	3	1	1
No microwave	59	32	7	11	1	0
None reported	57	42	6	10	0	1

Only one line—115 kv—reports a telephone line on the transmission structures; only 11 lines have a pilot-wire circuit.

Carrier is used on 57.5% of the lines, and, on the average, two frequencies are used on each line. The bulk of the installations use carrier frequencies between 30 and 150 kc.

Only 7% of the lines have microwave systems associated; the 1860-1940 mc band is most common and the 6800-7100 mc band next.

Cycles of Reclosure Delay—No. of Lines

Kv	100-131	131-150	151-200	201-250	251-300	301-400
None or Inst	31	13	4	7	0	1
No Auto. Recl	12	13	3	5	1	0
Manual	6	17	1	0	0	0
2-5 Cycles	5	6	0	0	0	0
10-15	5	4	0	2	0	0
16-20	22	21	10	1	0	0
20-25	0	3	0	11	1	1
25-30	4	14	0	0	0	0
35	1	2	0	0	0	0
6, 20, 45	1	1	0	0	0	0
0, 15, 60	2	0	0	0	0	0
60	2	0	0	0	0	0
120	.....	0	0	1	0	0
180	2	1	0	1	0	0
240	1	0	0	0	0	0
300	13	1	0	0	0	0
660	1	0	0	0	0	0
720	1	0	0	0	0	0
900	1	7	1	0	0	0
1800	2	0	0	0	0	0
Aver Cycles	**19.1**	**12.6**	**7.3**	**37.3**	**20.0**	**20.0**

Twenty percent of the lines use instantaneous reclosure or inject no delay; 8% have no automatic reclosure, and another 8% report manual reclosure. Sixteen to 20 cycles is a most common delay, but the actual reported values and even the averages vary widely.

Differs from Joint AIEE-EEI Report . . . This survey of transmission construction covers many of the same lines as were analyzed by the Joint AEII-EEI Committee on Line Outages almost two years ago. The objectives of that survey were to determine the causes of line outages, to correlate the causes with line and system characteristics, and to summarize this information to guide line design and operation.

But Electrical World's objective is to ascertain the characteristics built into lines after the extensive engineering advances of the past several decades. To this end, data have been assembled for lines built within the past 10 to 15 years. The number is thereby reduced to 281 (although several entries represent a group of lines of similar design) compared with the Joint Committee's 689, but the composite demonstrates recent practice.

The Joint Committee's survey of performance found that 64.6% of line outages were caused by lightning. The greater use of wood structures and of overhead ground wires in Electrical World's survey reflect the modern practice of combatting lightning. So does the use of counterpoises to improve structure grounding.

Solid grounding of the neutral, reported for 95% of modern lines, and high-speed circuit breakers (average 5.57 cycles) mark the provisions for clearing trouble before temporary faults become permanent. Automatic reclosing 60 cycles or less was reported for 20% of the modern lines. And 57.5% use carrier, pilot wire or microwave links for rapid clearing of faults, compared with 21% in the earlier Joint Report.

Electrical World's survey spotlights the modern trends. It supplies valuable additional information to assist in the design and operation of transmission lines.

Characteristics of Typical Modern Transmission Lines in the

Region	NEW ENGLAND									
Company	**Central Maine Power Co**			**Public Service Co, of New Hampshire**			**Brockton Edison Co**	**Boston Edison Co**		
Line designation (Name or No.)	Sect. 61	Sect. 69	Sect. 80	X-178	U-181	E-194	D-P-110	211-507	211-508	505-509
Voltage (nominal)-kv	115	115	115	115	115	115	115	110	110	110
Frequency-cps	60	60	60	60	60	60	60	60	60	60
Length-miles	118.47	31.89	26.71	53.0	46.6	54.0	5.07	13.36	13.36	7.4
Originates at	Lewiston	Wiscasset	Windsor	Groveston SS	Schiller Sta.	Schiller Sta.	Dupont Sta.	Wolburn	Wolburn	Braintree
Terminates at	Norway	Pownal	Rockland	N. Woodstock	Hudson	Greggs S.S.	Plymouth St. Sta.	Waltham	Waltham	Whitman
Year of constr. (or recons)	1946	1948	1950	1948	1949	1952	1949-1950	1948	1952	1953
Rating per cct.-Mva	50	50	.....	40	41	52	New	75	75	130
STRUCTURES										
(S)teel, (W)ood, (A)lum.	W	W	W	W	W	W	W	W	W	W
Av. No. per mile	11.2	11.3	10.9	11.1	11.3	12.15	14	12.3	11.8	11.8
Types (S)q, (A)-or (H)-frame*	H (W-16)	H (W-16)	H (W-16)	H (W-16)	H (W-16)	H (W-16)	H (W-3)	H (W-4)	H (W-4)	H (W-4)
Min. flashover-60 cps kv	335	335	335	335 (wet)	335 (wet)	335 (wet)	335	335 (wet)	335 (wet)	335 (wet)
No. of circ. (D)nst. (P)rov.	1	1	1	1	1	1	1	1	1	1
Crossarms, (W)ood, (S)teel, (A)lum.	W	W	W	W	W	W	Spar.	W	W	W
Bracing (S)teel, (W)ood	W	W	W	W	W	W	W	W	W	W
Av. weight per struc.-lb	.....	.....	.....	.....	.....	.....	6,900	.....	.....	.....
Insul. in guys (W)ood, (P)orc.-kv	None	None	None	None	None	None	W (77 in.)	2 x 12 W (110)	2 x 12 W (110)	2 x 12 W (110)
CONDUCTORS										
C, A, S, ACSR, Cw, (H)ollow	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	Cw	C	C	C(Hytherm)
Diam. cir mil or gage	266,800	266,800	266,800	336,400	336,400	477,000	211,600	4/0	4/0	350,000
Stranding	6/7	6/7	6/7	26/7	26/7	26/7	4Cw-15Cu	7	7	19
Weight per ft-lb	0.3433	0.3433	0.3433	0.4624	0.4624	0.6557	0.7484	0.6533	0.6533	1.081
Designed for ___ amp	250	250	250	200	205	260	800	390(S)-440(W)	390(S)-440(W)	670(S)-730(W)
Ph. config. (V)ert, (H)or, (T)riang.	H	H	H	H	H	H	H	H	H	H
Cond. offset from vert.-ft	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Phase separation-ft	14	14	14	14	14	14	14	14	14	14
Span, normal-ft	490	490	490	473	466	434	.....	425 (Av.)	450 (Av.)	440 (Av.)
Span, max.-ft	800	800	800	750	780	700	500	731	702	600
Sag final-ft at deg F	12.3, 120 F	12.3, 120 F	12.3, 120 F	12.3, 120 F	12.3, 120 F	12.3, 120 F	5	.....	.....	.....
Tension corresponding	850	850	850	1,180	1,180	1,470	3,000	4,000 des. (NESC. Hy)	4,577 (NESC. Hy)	7,785 (NESC. Hy)
Min. clear. to ground-ft	22	22	22	24	24	24	25	25 (120 F)	25 (120 F)	25 (200 F)
Min. clear. to struct-ft	3½	3½	3½	3½	3½	3½	4	5 (0° SW)	9 (0° SW)	5 (0° SW)
Type armor at clamps	Alum. Liners	Alum. Liners	Alum. Liners	Alum.	Alum.	Alum.	Copper Liners	None	None	None
Type vibration dampers	None	None	None	None	None	None	None	None	None	None
Line altutide range-ft	320 to 860	20 to 240	40 to 400	690 to 2610	20 to 500	20 to 600	107 to 220	80 to 335	80 to 335	100 to 220
Max. corona loss-kw/3-ph. mile	.....	.....	.....	.....	.....	.....	3,378	.....	.....	.....
INSULATION										
Basic imp. insul. clvel-kv	1,400	1,400	1,400	1,400	1,400	1,400	750	1,150	1,150	1,150
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	8 x 10	8 x 10	8 x 10	8 x 10	8 x 10	8 x 10	8 x 120	8 x 485/335	8 x 485/335	8 x 485/335
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	9 x 10	9 x 10	9 x 10	10 x 10	10 x 10	10 x 10	10 x 120	8 x 485/335	8 x 435/335	8 x 485 335
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	Line Tap
No. units and kv rating (or in.)	10 x 10	10 x 10	10 x 10	10 x 10	10 x 10	10 x 10	10 x 120	7	7	.....
Impulse reduction-kv or %	.....	.....	.....	.....	.....	.....	.....	12%	12%	.....
BIL of term. apparatus-kv	550	550	550	550	550	550	.....	.....	.....	.....
IMPULSE SURGE PROTECTION										
No. of ground wires	2	2	2	2	2	2	2	2	2	2
Grd. wire matl. and size	3x7 EHS Cw	3x7 EHS Cw	3x7 EHS Cw	3x6 Cw	3 x 6 Cw	⅝ HS St.	3x6 Cw	⅝ HS St.	⅝ HS St.	⅝ HS St.
Angle of prot.-deg	45	45	45	45	45	45	30	29	29	29
Grd. wire clear., mid-span-ft	12	12	12	12	12	12	14	16	13 to 16	13 to 16
Grd. res. range-ohms	.....	.....	.....	.....	.....	.....	10 to 15	.....	.....	.....
Counterpoise (L)inear, (C)rowfoot	None	None	None	None	None	None	L	L	L	L
Neut. gdg. (S)olid, (R), (X), (T)ransf.	S	S	S	S	S	S	S	S	S	S
Neut. gdg.-equiv. ohms	0	0	0	0	0	0	0	.....	.....	.....
Arrester rating-kv	97	97	97	97	97	97	97	.....	.....	.....
Expulsion tube gap-in.	None	None	None	None	None	None	None	.....	.....	.....
Arcing horn gap-in.	None	None	None	None	None	None	None	.....	.....	.....
Arcing ring top diam-in.	None	None	None	None	None	None	None	.....	.....	.....
Arcing ring bot. diam.-in.	None	None	None	None	None	None	None	.....	.....	.....
Type relaying	GCX	GMB	HCZ	Dist.	Dist. Carr.	Dist. Carr.	H. Z. Imp.	Imp. Carr.	Imp. Carr.	Mod. Imp. Carr.
Breaker interruption-cycles	5	5	5	5	5	5	8	5	5	5
Reclosure delay-cycles	20	20	20	Manual	20-one end 5 sec. other	20-one end 5 sec. other	No. Recl.	None	None	None
VOLTAGE REGULATION										
Nominal-%	10	10	10	5	5	5	None	.....	.....	.....
Synch. cond.-kva	20,000	16,800 (H)	.....	None	None	None	None	.....	.....	.....
Synch. cond. spacing-miles	Center	.....	.....	.....	.....	.....	None	.....	.....	.....
Shunt cap.-kva	60,000	.....	.....	None	None	None	None	.....	.....	.....
Shunt cap. spacing-miles	System	.....	.....	.....	.....	.....	None	.....	.....	.....
Series capacitor-kva	None	.....	.....	None	None	None	None	.....	.....	.....
COMMUNICATION										
Telep circ on struct	None	None	None	None	None	None	None	None	None	None
Carrier frequency-kc	52	52	52	82	82	82	None	155	145	130
Pilot wire	None	None	None	None	None	None	None	.....	.....	.....
Microwave-Mc	None	None	None	None	None	None	None	.....	.....	.....

* Parentheses refer to configuration diagrams on page 150

NEW ENGLAND

Boston Edison Co

282-507	282-507	240-508	240-507	65-508
110	110	110	110	110
60	60	60	60	60
7.25	7.15	10.7	10.7	10.0
Framingham	Sudbury	Medway	Medway	Walpole
Sudbury	Waltham	Framingham	Framingham	Medway
1953	1953	1940	1950	1951
130	130	75	75	90
W	S	W	W	W
12.2	13.6	13.6	12.0	12.1
H (W-4)	S (S-11)	H (W-4)	H (W-4)	H (W-4)
335 (wet)	415 (wet)	335 (wet)	335 (wet)	335 (wet)
1	1(I), 1(P)	1	1	1
W	S	W	W	W
W	S	W	W	W
.....	12,800	.....	.....	.....
2 x 12 W(110)	.....	2 x 12 W(110)	2 x12W(110)	2x12W(110)
C(Hytherm)	C(Hytherm)	C	C	C(Hytherm)
350,000	350,000	4/0	4/0	4/0
19	19	7	7	7
1.081	1.081	0.6533	0.6533	0.6533
670(S)	670(S)	390(S)	390(S)	480(S)
730(W)	730(W)	440(W)	440(W)	530(W)
H	V	H	H	H
.....	2	.....	.....	.....
14	13 & 14	14	14	14
440(Av)	375(Av)	385	440	430
1,031	500	505	605	1,000
.....	.....	.....	.....	.....
7,785	4,500	4,000	4,577	4,577
(NESC Hy)	(NESC Hy)	(NESC Hy)	(NESCHy)	(NESC Hy)
25 (200F)	40	25 (120F)	25 (120F)	25 (200F)
5 (0° SW)	5¾ (30° SW)	5 (0° SW)	5 (0° SW)	5 (0° SW)
.....	Bronze	None	None	None
.....	.....	None	None	None
116 to 194	87 to 187	200 to 290	200 to 290	120 to 275
.....	.....	.....	.....	.....
1,150	.....	1,150	1,150	1,150
D	D	D	D	D
8	10(Sus)	8	8	8
	12(D.E.)			
D	D	D	D	D
8	12	8	8	8
Line Tap	D	D	D	D
.....	12	7	7	7
.....	None	12½	12½	12½
.....	.....	.....	.....	.....
2	2	2	2	2
⅝ H.S. St	1/0Type K 213	⅝ HS St	⅝ H.S. St	⅝ H.S. St
29	9	29	29	29
3 to 16	12 to 14	13 to 16	13 to 16	13 to 16
.....	.....	.....	.....	.....
L	L	L	L	L
S	S	S	S	S
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
Imp. Carr.	Imp. Carr.	Imp. Carr.	Imp. Carr.	Imp. Carr.
5	5	5	5	5
None	None	None	None	None
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
120	120	120	110	145
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....

New England Elec. System

Q-143	W-149	A-153
115	115	115
60	60	60
30.5	40	8.6
Millbury	Bellows F'ls	Salem
Providence	Wilder	Wakefield
1946	1950	1951
100	100	200
W	W	W
13	13	13
H	H	H
1,000	1,000	1,000
1	1	1
W	W	W
.....	.....	.....
W	W	None
C	ACSR	ACSR
4/0	336,400	795,000
7	30/7	54/7
0.645	0.527	1.024
500	500	1,000
H	H	H
.....	.....	.....
10 & 12	10 & 12	10 & 12
400	400	400
600	600	600
13	13	13
2,500	2,700	4,000
24	24	24
6	6	6
None	Rods	Rods
None	None	None
25 to 500	300 to 1,500	10 to 200
worst w'ther	worst w'ther	worst w'ther
1.22	0.12	small
2,300	2,300	2,300
D	D	D
8 x 5¾	8 x 5¾	8 x 5¾
D	D	D
8 x 5¾/10	8 x 5¾/10	8 x 5¾/10
D	D	D
7 x 5¾/10	7 x 5¾/10	7 x 5¾/10
None	None	None
550	550	550
1	1	1
⅝ Galv. St	⅝ Galv. St	⅝ Galv. St
60	60	60
23	23	23
100 to 2,000	100 to 2,000	50 to 400
None	None	None
S	S	S
.....	.....	.....
97	97	97
None	None	None
None	None	None
None	None	None
18 x 30	18 x 30	18 x 30
Dir. Comp.	Dir. Comp.	Dir. Comp.
8	8	8
35	900	20
7.0	9.0	1.5
None	None	None
.....	.....	.....
None	None	None
.....	.....	.....
None	None	None
None	None	None
145	120	130 & 160
None	None	None
None	None	None

Connecticut Light and Power Co

17,200-17,300	16,000	15,800-15,900
115	115	115
60	60	60
23.3	74.7	26.7
Devon	Devon-Montville	Devon
Norwalk	Southington	Bunkerhill
1950	1946	1949
66.7	80	66.7
S	W	S
8	9	8
S (S-10)	H (W-3)	S (S-10)
550	500	550
2	1	2
S	W	S
S	W	S
9,500	7,000	8,500
.....	W	.....
C	C	C
4/0	4/0	4/0
7	7	7
0.653	0.653	0.653
450	450	450
V	H	V
8	.....	8
10 & 12	13	8½ & 10½
660	580	660
1,410	1,610	1,610
89(60F)	117(60F)	117(60F)
1,820	1,800	1,800
27	27	27
8	6½	8
None	None	None
None	None	None
0 to 340	0 to 780	0 to 830
.....	.....	.....
845	1,220	845
D	D	D
9	8	9
D	D	D
11	9	11
D	D	D
11	11	11
.....	.....	.....
550	550	550
2	2	2
11/32 Cw	11/32 Cw	11/32 Cw
30	30	30
11	12	11.5
40 (max)	40 (max)	40 (max)
L	L	L
S	S	S
.....	.....	.....
109	109	109
None	None	None
None	None	None
None	None	None
None	None	None
Dist.	Dist. Carr. & Dir. Gnd.	Dist. Carr. &Dir.Gnd.
8	8	8
No delay	No delay	No delay
14%	14%	14%
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	89 & 91	85 & 115
.....	.....	.....
.....	.....	.....

MIDDLE ATLANTIC

New York State Elec. and Gas Corp

944	968
114	114
60	60
30.2(S)	43.6
1.8(W)	
Jennison Sta	Greenidge Sta
Goudey Sta	Meyer Sta
1950	1949
132	50
S-1.8 W-30.2	W
W-7.4 S-6.1	8.13
S, H (W-5)	H (W-3)
S-335 W-295	295
1-W 2-S	1
W(W) S(S)	W
W(W) S(S)	W
11,000	.....
W(850)	W(850)
ACSR	ACSR
477,000	336,400
30/7	30/7
0.747	0.527
670	530
H(W) V(S)	H
3.5	.....
12(W), 10(S)	12
710(W), 860(S)	650
2,128(W) 1,330(S)	1,938
118, (60F 2,128 ft)	89
3,100	2,800
26 (Loaded)	26 (Loaded)
.....	.....
Rods	Rods
Rods	Rods
830 to 1,650	500 to 2,040
under 0.1	under 0.1
1200(W) 760(S)	1,200
D	D
7(W), 8(S)	7
D	D
9(W), 10(S)	9 or 7
D	D
9(W), 10(S)	9
None	None
550	550
2	2
⅝ Cw	⅝ Cw
30	30
13.5 (1,200ft)	13 (V)
30 to 350	not tested
None	None
S	S
0	0
97	97
11(S)	None
None	None
None	None
None	None
Dir. Comp. Carr.	Dir. Dist. & Gnd. Dir. OC
.....	.....
10	720
under 10%	under 10%
None	None
None	None
None	None
None	None
None	None
None	None
94	None
None	None
None	None

Characteristics of Typical Modern Transmission Lines in the

Region	MIDDLE ATLANTIC									
Company	**Niagara Mohawk Power Corp**			**Central Hudson Gas and Electric Corp**			**N. Jersey Power & Light Co**	**Pennsylvania Electric Co**		**Metro.**
Line designation (Name or No.)	13	9 (new sect.)	10	A	M	X	.....	Fr. Rd. to Morgan	Farm's-R'dg'w'y	Middlet'n Jn. to Co. Line
Voltage (nominal)-kv	115	115	115	110	110	110	115	115	115	115
Frequency-cps	60	60	60	60	60	60	60	60	60	60
Length-miles	70.5	23.5	23.5	20.8	9.3	26.55	46.4	35	35	48.5
Originates at	Utica	Oswego	Oswego	Pleasant Val.	Marlboro	Pleasant Val.	Gilbert	Erie	Farmers Val.	Middlet'n Jn.
Terminates at	Schenectady	Long Branch	Long Branch	Marlboro	East Walden	East Walden	W. Wharton	Meadville	Ridgeway	Co. Line
Year of constr. (or recons)	1948–1949	1949	1949	1947 new	1951 new	1943 rebuild	1953 new	1942	1952–1953	1950
Rating per cct.-Mva	120	160	160	113	103	91.6	150	40	60	70
STRUCTURES										
(S)teel, (W)ood, (A)lum	W	W	W	W	W	W	W	W	W	W
Av No. per mile	9	10	10	11.5	10	11.1	10	10	8	7.1
Types (S)q, (A)-or (H)-frame*	H	H	H	H (W-3)	H (W-14)	(S-3)	H (W-7)	H (W-14)	H (W-14)	H (W-4)
Min. flashover-60 cps kv	335	500	500	820	820	540	380	.....	.....	255
No. of circ. (I)nst. (P)rov	1(I); 1(P)	1	1	1	1	1	1–1	1	1	1
Crossarms, (W)ood, (S)teel, (A)lum	S	S	S	Spar	Spar	S	W	W	W	W
Bracing (S)teel, (W)ood	None	W	W	W	W	S & W	W	W	W	W
Av. weight per struc.-lb	.....	.....	.....	6,500	6,500	8,000	.....	.....	.....	7,100 lb
Insul. in guys (W)ood, (P)orc.-kv	None	None	None	W	W	W	None	W	W	W
CONDUCTORS										
C; A, S, ACSR, Cw, (H)ollow	ACSR	ACSR	ACSR	ACSR	C	C	ACSR	C	ACSR	ACSR
Diam, cir mil or gage	795,000	636,000	636,000	0.783	0.574	0.552	556,500	2/0	636,000	336,400
Stranding	26/7	26/7	26/7	26/7	12	7	26/7	7	24/7	30/7
Weight per ft-lb	1.094	0.875	0.875	0.5464	0.7719	0.6533	0.765	0.411	0.82	0.5261
Designed for ___ amp	.....	800	800	590	540	480	750	200	300	530
Ph. config. (V)ert, (H)or, (T)riang.	H	H	H	H	H	V	H	H	H	H
Cond. offset from vert.-ft	.....	.....	.....	.....	.....	3	.....	.....	.....	.....
Phase separation-ft	12½	10	10	16	16	9½	12	12	12	12
Span, normal-ft	550	550	550	460	530	510	600 (1 in. Ice)	520	660	800
Span, max.-ft	1,035	650	650	805	1,020	882	1,070 (1 in. Ice)	1,400	1,800	1,703
Sag final-ft at deg F	49, (60 F)	20, (60 F)	20, (60 F)	22	39	32	13.46 (120 F)	15 (120 F)	16 (120 F)	16.5 (60 F)
Tension corresponding	3,000	2,150	2,150	7,500 (max.)	6,180 (max.)	5,000 (max.)	3,600 (60 F)	950	2,800	2,550
Min. clear. to ground-ft	25	27	27	23	23	23	27 (120 F)	24	24	30 (60 F)
Min. clear. to struct-ft	5¾	5	5	5 1/6	5 1/6	4¼	5.5	6 (No Wind)	6 (No Wind)	3½
Type armor at clamps	Alum. Taprd	None	None	Tapred Rods	None	None	Preformed	None	Preformed	Tapered
Type vibration dampers	None	None	None	None	None	None	None	None	None	None
Line altitude range-ft	500 to 1,400	350 (avg)	350 (avg)	0 to 500	100 to 733	0 to 600	200 to 1,100	1,000 to 1,400	1,300 to 2,200	400 to 900
Max. corona loss-kw/3-ph. mile	Negligible	0.1	0.1	.....	.....	.....	.....	.....	.....	None
INSULATION										
Basic imp. insul. level-kv	630	800 (E)	800 (E)	1,350	1,350	860	1,100	760	670	610
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	8 (422)	8 (500)	8 (500)	10	10	9	6	7	7	6 x 255
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D -
No. units and kv rating (or in.)	11 x 527	9 x 540	9 x 540	10	10	9	10	9	8	7 x 295
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	11 x 527	9 x 540	9 x 540	11	11	9	10	9	9	8 x 335
Impulse reduction-kv or %	None	.....	.....	.....	.....	.....	None	.....	.....	.....
BIL of term. apparatus-kv	550	550	550	550	550	550	550	550	550	450
IMPULSE SURGE PROTECTION										
No. of ground wires	2	1	1	2	2	2	2	2	2	2
Grd. wire matl. and size	⅜ EHS Cw	Cw	Cw	101,800ACSR	⅜ Cw	⅜ St	7/16 & ½ St	3, 7 Cw	101,800ACSR	2-3 No. 6 EHS-Cw
Angle of prot-deg	45	48	48	27	30	46	30	33	33	35
Grd. wire clear., mid-span-ft	13.25 (V)	17	17	20	18½	11½	15	15	15	15
Grd. res. range-ohms	Not Rec	50 to 500	50 to 500	10 to 400	20 to 250	.....	15	.....	.....	.....
Counterpoise (L)inear, (C)rowfoot	Pole butt wrapped	L	L	None	None	None	L	L (Cont.)	.....	L, C
Neut. gdg. (S)olid, (R), (X), (T)ransf	S	S	S	S	S	S	S	S	S	S
Neut. gdg.-equiv. ohms	.....	0.5	0.5	None	None	None	.....	.....	.....	.....
Arrester rating-kv	92	None	None	97	97	97	115	111	111	97
Expulsion tube gap-in	None	None	None	None	None	None	None	.....	.....	.....
Arcing horn gap-in	38	None	None	None	None	None	None	.....	.....	.....
Arcing ring top diam.-in	.....	None	None	None	None	None	None	.....	.....	.....
Arcing ring bot. diam.-in	.....	None	None	.....	.....	.....	None	.....	.....	.....
Type relaying	Dist. & Gnd. Dir.	Dist. dir. & Grd. dir.	Dist. dir. & Grd. dir.	Dist. Comp. Carr; Dir. Dist. & PRO	Dir. Comp. Carr; Dir. Dist.	Dir. Dist. PRO Gnd.	Carr. Dist. & Dir. Gnd.	Carr.	Carr.	Carr. Dist. & Dir. OC; Gnd. BU
Breaker interruption-cycles	8	5 & 8	5	5	5	8	5	5	S	8
Reclosure delay-cycles	1,800	240	660	None	None	None	Inst; Subseq. Man.	15	15	H. S.
VOLTAGE REGULATION										
Nominal-%	.....	.....	.....	None	None	None	.....	.....	.....	.....
Synch. cond.-kva	30,000 (Term'l. only)	None	None	None	None	None	.....	.....	.....	.....
Synch. cond. spacing-miles	.....	None	None	None	None	None	.....	.....	.....	.....
Shunt cap.-kva	None	None	None	None	None	None	.....	.....	.....	.....
Shunt cap. spacing-miles	None	None	None	None	None	None	.....	.....	.....	.....
Series capacitor-kva	None	None	None	None	None	None	.....	.....	.....	.....
COMMUNICATION										
Telep circ on struct	None	None	None	None	None	None	None	.....	.....	.....
Carrier frequency-kc	.....	73	.....	80	114	71, 94, 124	None	.....	.....	.....
Piliotwire	.....	None	None	None	None	None	None	.....	.....	.....
Microwave-Mc	.....	None	None	None	None	None	None	.....	.....	.....

* Parentheses refer to configuration diagrams on page 150

	EAST NORTH CENTRAL				WEST NORTH CENTRAL								
Edison Co	Detroit Edison Co		Wisconsin Public Service Corp		Minnesota Pwr & Light Co	Northern States Power		Otter Tail Power Co			Iowa Elec. Light & Power Co	Kansas City Power & Light Co	
Gilbert to Hosensack	Newburgh to Superior	St. Clair to No. East 1-2	T-20, S-4 S	J-36	39	825-826	821	Wahpeton-Fergus Falls	Fergus Falls-Ortonville	Ortonville-Granite Fls	Cedar Rpds-Marsh'lt'wn	Westinghouse	
115	120	120	115	115	115	115	115	115	115	115	115	110	
60	60	60	60	60	60	60	60	60	60	60	60	60	
20.7	13.15	13.15	79	90	25.4	138.34	7.89	29½	90	87	64.25	22	
Gilbert..... Hosensack	Newburgh SS Superior SS	St. Clair Sta. No. East SS	Wausau Petenwell Dam	Greenbay Wausau	Aurora SE Virginia SS	Granite Fls Sioux Falls	St. Paul Minneapolis	Wahpeton Fergus Falls	Fergus Falls Ortonville	Ortonville Granite Fls	Cedar Rapids Marsh'lt'wn	Kansas City Kansas City	
1952-1953	1951	1952-53	1946-49	1950	1953	1952	1943	1950-1951	1951-1952	1952-1953	1941	1943	
145	110(40 C rise)	160(40 C rise)	.....	.....	80	35 (sys stab)	100(sysstab)	30	30	30	35	40	
W	S	S	W	W	W	W	W	W	W	W	W	W	
6.9	7.1	6.3	9	9	9	8	8	8	8	8	8	10.3	
H (W-4)	S(S-2)	S(S-2)	H (W-13)	H (W-13)	H	H (W-14)	1p (W-21)	H (W-4)	H (W-4)	H (W-4)	H (W-4)	H (W-4)	
255	335 (wet)	335 (wet)	.....	.....	400	.....	.....	.....	.....	.....	295	295	
1	(I) 1; (P) 2	2	1	1	1	1	1	2	2	2	1	1	
W	S	S	W	W	W	W	W	W	W	W	W	W	
W	S	S	W	W	None	W	W	W	W	W	5,000	W	
7,100 lb	10,230 lb	10,870 lb	5,200	5,200	.....	.....	.....	.....	.....	.....	.....	6,200	
W	No guys	No guys	W	W	None	W	W	None	None	None	W	None	
ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	C	ACSR	ACSR	ACSR	Cw	C	
556,500	477,000	795,000	4/0	336,400	336,400	77,000	4/0	266,800	266,800	266,800	2/0	4/0	
26/7	26/7	26/7	6/1	26/7	26/7	26/7	7	26/7	26/7	26/7	9/3	7, 12, 19	
0.765	0.6557	1.098	0.291	0.463	0.463	0.6567	0.653	0.366	0.366	0.366	0.473S	0.6533	
730	665	900	340	530	400	.....	.....	.....	.....	.....	360	480	
H	V	V	H	H	H	H	T	H	H	H	H	H	
.....	3	3	.....	.....	.....	.....	6, 7, 8	.....	.....	.....	.....	.....	
12	11.4 to 12.4	11.4 to 12.4	14½	14½	11	14½	13 to 15	12.5	12.5	12.5	13½	13½	
800	870	900	550	550	650	660	300	660	660	660	660	515	
1,155	1,000 (0° Angle)	900 (0°)	700	700	1,000	1,100	900	765	1,080	1,100	1,500	1,176	
14.5 (60 F)	21.5 (60 F)	19.0 (60 F)	13.8 (60F, 650ft)	13.8 (60F, 650 ft)	10 (60 F)	16½ (120F,660ft)	4½ (120F,300ft)	9.9 (60 F)	9.9 (60 F)	9.9 (60 F)	12 (60 F)	20.2 (60 F)	
4,200	2,900	5,875	1,210	1,770	2,400	2,200	1,850	1,750	1,750	1,750	2,130	2,270	
28.5 (60 F)	28 (60 F)	28 (60F)	28½	28½	27	27¾	26	26½	26½	26½	26	25	
3½	3.5	3.5	7	7	3	.....	.....	3.0	3.0	3.0	3.2	3.92	
Tapered	Preformed	Preformed	Preformed	Preformed	Tapered Rds	Tapered	None	Tapered Al	Tapered Al	Tapered Al	HD Cu Rods	None	
None	Stockbridge	Stockbridge	Stockbridge	Stockbridge	None	Stockbridge	None	None	None	None	None	None	
200 to 600	660 to 820	587 to 715	600	600	1300 to 1800	100 to 1200	800 to 1000	900 to 1000	900 to 1000	900 to 1000	600 to 700	750 to 1100	
None	0.076	0.05	.....	.....	1±	.....	.....	.....	.....	.....	1	0.20	
610	780	780	.....	.....	550	.....	.....	825	825	825	1,000	800 (wet)	
D	D	D	D	D	D	D	D	D	D	D	D	D	
6 x 255	8 x 10	8 x 10	8 x 80/50	8 x 80/50	7 x 670	7	6	7	7	7	7 x 10	7 x 80	
D	D	D	D	D	D	D	D	D	D	D	D	D	
7 x 295	8-9 x 10	8 x 10	11 x 80/50	11 x 80/50	9 x 845	.....	.....	9	9	9	8 x 10	12 x 80	
D	D	D	D	D	D	D	D	D	D	D	D	D	
8 x 335	8-9 x 10	8 x 10	11 x 80/50	11 x 80/50	9 x 845	2 x 8	7	9	9	9	11 x 10	10 x 80	
.....	None	None	.....	.....	0	.....	.....	.....	.....	.....	.....	0	
450	550 Trs	550 Trs	.....	.....	550	550	550	450	450	450	550	550	
2	1	1	2	2	2	2	2	2	2	2	2	2	
⅝ EHS "C"	⅝ St	7/16 St	⅝ HS St	⅝ HS St	⅝ Cw	⅝ St	No. 1 Cw (30%)	⅝ HS	⅝ HS St	⅝ HS St	11/32 Cw	3 No. 5 HS Cw ⅝ HS St	
35	43	43	30	30	25	31	30	33	33	33	30	33	
14	19.9	20.5	13.5	13.5	11	15.8 (60F, 660 ft)	.....	13	13	13	16	22	
10 (opt)	1 to 6	3 to 10	10	10	20 to 100	20 Max. Av. Gnd Rods	5 Max. Av. Gnd Rods	.....	.....	.....	1 to 10	10 Max.	
L, C	None	None	.....	.....	.....	.....	.....	None	None	None	None	None	
S	None	S	T	T	S	S	S	S	S	S	S	S & T	
.....	None	.....	1	1	.....	0	0	0	0	0	0	0.025-0.6	
97	97	97	115	115	121	97	97	97	97	97	121	97	
.....	None	None	.....	.....	.....	None	None	None	None	None	None	None	
.....	None	None	.....	.....	22½ in. Fused	None	None	None	None	None	None	None	
.....	None	None	.....	.....	.....	None	None	None	None	None	None	None	
.....	None	None	.....	.....	.....	None	None	None	None	None	None	None	
Carr. Dist. & Dir. OC; Gnd. BU	Ph. & Gnd. Dir. Comp. Carr.;OC BU	Ph. & Gnd. Dir. Comp. Carr.;OC BU	HZ, CRC	HZ, CRC	Dist.	Imp. Carr. Gnd.	Imp. Car. Gnd.	Dist.	Dist.	Dist.	Carr. with BU	Dir. Dist.	
8	5	3 to 5	8	8	5	6	6	5	5	5	5	5	
H.S.	No Recl.	No Recl.	6-20-45(Sec)	6-20-45(Sec)	.....	180	No Reclo.	20	20	20	No. Reclo.	20	
.....	0.6	12.5	+4	+4	3	5	5	10	10	10	10	20	
.....	None	60 Mva at North East	.....	.....	0	.....	.....	None	None	None	None	None	
.....	None	at Station	.....	.....	0	.....	.....	None	None	None	None	.....	
.....	None	None	5,370	6,135	0	.....	.....	None	None	None	None	None	
.....	None	None	.....	.....	0	.....	.....	None	None	None	None	.....	
.....	None	None	.....	.....	0	.....	.....	.....	.....	.....	None	None	
.....	152.8	135	.....	.....	0	50	.....	70 & 150	135 & 150	90 & 70	50 to 200	None	
.....	None	None	.....	.....	0	.....	.....	.....	.....	.....	None	None	
.....	None	None	.....	.....	0	.....	.....	.....	.....	.....	None	None	

Characteristics of Typical Modern Transmission Lines in the

Region	W.N. CENTRAL			SOUTH ATLANTIC							
Company	Kansas Power & Light Co			Consolidated Gas, Electric Light & Power Co				Georgia Power Co			
Line designation (Name or No.)	Hutchinson	S.O.W.	Seneca	A	B	C	D	Mil'dgeville-Warrington	Yates-Americus	Augusta-So. Augusta	Gordon-Wadley
Voltage (nominal)-kv	115	115	115	110	110	110	110	115	115	115	115
Frequency-cps	60	60	60	60	60	60	60	60	60	60	60
Length-miles	160	30	60	10.83	9.68	19.68	5.88	40.30	111.272	3.90	58.70
Originates at	Tecumseh	Tecumseh	Tecumseh	Sub. Sta.	Sw. Sta.	Sw. Sta.	Sw. Sta.	Milledgeville Sub.	Yates Sta.	Augusta SS	Gordon SS
Terminates at	Hutchinson	S.O.W.	Seneca	Sub. Sta.	Sub. Sta.	Sw. Sta.	Sub. Sta.	Warrington Sub.	Americus SS	So. Augusta SS	Wadley SS
Year of constr. (or recons)	1947	1942	1950	1952	1942	1951–52 (Rebuilt)	1950	1941	1952	1950	1949
Rating per cct.-Mva	.....	.....	.....	103	70	103	75	50	50	20	20
STRUCTURES											
(S)teel, (W)ood, (A)lum	W	W	W	W, S	W	S	S	W	W	W	W
Av No. per mile	8	8	8	10W, 11S	10	13	13	6.97	6.94	17.69	7.27
Types (S)q, (A)-or (H)-frame*	H (W-6)	H (W-6)	H (W-6)	H, S(S-11)	H (W-1)	S (S-8)	(S-8)	(W-10)	(W-10)	sing. pole (W-20)	H (W-10)
Min. flashover-60 cps kv	.....	.....	.....	S-540 (dry) W-685 (dry)	685 (dry)	540 (dry) 375 (wet)	540 (dry) 375 (wet)	375	295	295	295
No. of cir. (I)nst. (P)rov	1	1	1	1	1	2	2	1	1	1	1
Crossarms, (W)ood, (S)teel, (A)lum	W	W	W	W (Wood) S (Steel)	W	S	S	Dbl Planked	W (spar)	W (wish-bone)	W (spar)
Bracing (S)teel, (W)ood	W	W	W	W	W	S	S	None	None	W	.....
Av weight per struc.-lb	.....	.....	.....	11,270 (T'w'rs)	.....	11,270	10,069	.....	.....	.....	.....
Insul. in guys (W)ood, (P)orc.-kv	W	W	W	No Ins.	No. Ins.	No Guys	No Guys	W (700)	W (700)	570, 1200	W (700)
CONDUCTORS											
C, A, S, ACSR, Cw, (H)ollow	ACSR	ACSR	ACSR	ACSR	Cw	ACSR	C	Cw, C	ACSR	C	ACSR
Diam. cir mil or gage	266,800	266,800	266,800	556,500	9/16	556,500	4/0	4/0	477,000	4/0	366,400
Stranding	26/7	26/7	26/7	24/7	7	24/7	19	6C/1Cw	26A1/7st	7-Strand	26Al./7stl.
Weight per ft-lb	.....	.....	.....	0.716	0.649	0.716	0.658	0.7102	0.6566	0.6533	0.4630
Designed for __ amp	.....	.....	.....	495	335	495	360	.....	.....	.....	.....
Ph. config. (V)ert, (H)or, (T)riang	H	H	H	H	H	V	V	H	H	T	H
Cond. offset from vert.-ft	.....	.....	.....	.....	.....	3½	3½	.....	.....	.....	.....
Phase separation-ft	13½	13½	13½	12½	12½	11½	10.6	14	14	9¾,13 5/12, 14 10/12	14
Span, normal-ft	660	660	660	484 (W) 734 (S)	544	648	690	750	760	300	725
Span, max.-ft	880	880	800	1915 (S) 625 (W)	790	1417	1215	1375	1550	442	1735
Sag final-ft at deg F	.....	.....	.....	11.7 (W) 26.5 (S)	14.8	20	23.9	18¼ (120F,750ft)	16½ (760 ft)	6½ (300 ft)	13¾ (725 ft)
Tension corresponding	.....	.....	.....	5,138	4,000	6,000	4,000	2,750	2,840	1,065	2,225
Min. clear. to ground-ft	.....	.....	.....	30	25	30	25	25 (120 F)	24 (120 F)	30 (120 F)	18 (120 F)
Min. clear. to struct-ft	.....	.....	.....	6 (W) 3(S)	6	3	3	6½	6½	5 1/6	6½
Type armor at clamps	None	None	None	Tapered	None	Tapered	None	Rods	Rods	Rods	Rods
Type vibration dampers	None	None	None	Stockbridge	None	None	None	.....	Stockbridge	None	Stockbridge DE Only
Line altitude range-ft	800 to 1500	800 to 1000	800 to 1200	65	80 to 300	200 to 640	210 to 634	250 to 605	650 to 990	120 to 160	230 to 500
Max. corona loss-kw/3-ph. mile	.....	.....	.....	0	0.3	0	1.0	Negligible	Negligible	Negligible	Negligible
INSULATION											
Basic imp. insul. level-kv	.....	.....	.....	1150 (W) 860 (S)	1150	860	860	1300	1300	1105	1300
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	7	7	7	7 (W) ,9(S)	7	9	9	9 x 10	7 x 10	7 x 10	7 x 10
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	7	7	7	8(W), 10(S)	8	10	10	11 x 10	9 x 10	9 x 10	9 x 10
Term, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	7	7	7	10(W), 10(S)	10	10	10	7 x 10	7 x 10	7 x 10	7 x 10
Impulse reduction-kv or %	.....	.....	.....	.....	.....	.....	.....	750	750	555	750
BIL of term. apparatus-kv	.....	.....	.....	550 trans, 650 OCB	550 trans, 650 OCB	650 OCB	550 (TR) 650 (CB)	550	550	550	550
IMPULSE SURGE PROTECTION											
No. of ground wires	2	2	2	2	2	2	2	2	2	1	2
Grd. wire matl. and size	⅜ St	⅜ St	⅜ St	11/32 Cw	⅛ St	11/32 Cw	11/32 Cw	⅜ St	⅜ St	⅜ St	⅜ St
Cone angle of prot-deg	.....	.....	.....	24	24	4	4	27	28	33	28
Grd. wire clear., mid-span-ft	.....	.....	.....	28 Towers 21(H), 28(S)	22	20	27	23 (Av.90F)	20 (Av.90F)	11½	17½
Grd. res. range-ohms	.....	.....	.....	9 to 20	15 to 90 (3 to 29 cpse)	7 to 35 (2 to 20 cpse)	9 to 40 (1 to 5 cpse)	5 to 16	4 to 40	5 to 15	3 to 15
Counterpoise (L)inear, (C)rowfoot	.....	.....	.....	L	L	L	L	C	C	Ground Rods	C
Neut. gdg. (S)olid, (R), (X), (T)ransf	S	S	S	S	S	S	S	S	S	S	S
Neut. gdg.-equiv. ohms	.....	.....	.....	None	None	None	None	.....	.....	.....	.....
Arrester rating-kv	97	97	97	97	94 or 97	94 or 97	94 or 97	Gen Pl-97. Sub. Sta-121	Gen. Pl-97 Sub. Sta-121	Sub. Sta. 121	Sub. Sta. 121
Expulsion tube gap-in	.....	.....	.....	None	None	None	None	.....	.....	.....	.....
Arcing horn gap-in	.....	.....	.....	None	None	None	None	None	None	None	None
Arcing ring top diam.-in	.....	.....	.....	None	None	None	None	None	None	None	None
Arcing ring bot. diam.-in	.....	.....	.....	None	None	None	None	None	None	None	None
Type relaying	Pilot	Pilot	Dist.	HS Imp OCB	HS Imp OCB	HS Imp OCB	HS Imp OCB	Dist.	Dist.	Pilot wire	Dist.
Breaker interruption-cycles	8	8	8	5	5	5	5	5	5	5	5
Reclosure delay-cycles	Inst.	Inst.	Inst.	30	30	30	30	0-15-60 (sec)	One Shot	¼ min. Manual	0-15-60 (sec)
VOLTAGE REGULATION											
Nominal-%	.....	.....	.....	3-4	3-4	3-4	3-4	.....	.....	.....	.....
Synch. cond.-kva	50–150	50–150	50–150	.....	.....	.....	.....	.....	.....	.....	.....
Synch. cond. spacing-miles	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shunt cap.-kva	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shunt cap. spacing-miles	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Series capacitor-kva	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
COMMUNICATION											
Telep circ on struct	.....	.....	.....	.....	.....	.....	.....	None	None	None	3 No. 10 Cw
Carrier frequency-kc	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pilot wire	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Microwave-Mc	.....	.....	.....	.....	.....	950 mc	.....	.....	.....	.....	.....

* Parentheses refer to configuration diagrams on page 150

SOUTH ATLANTIC

	Virginia Electric and Power Co			South Carolina Electric & Gas Co							Florida Power Corp		
So. Macon-Vidalia 115 60 100.82 S. Macon Jt. Vidalia 1950 45	Petersburg-Suffolk 110 60 67.9 Petersbg Suffolk 1951	Chstrfld-Possum Pt. 110 60 100.2 Chstrfld St. Possum Pt. St 1951	Fredksbg-Oak Grove 110 60 27.3 Fredksbg Oak Grove 1952	Fairfax-Granitevle 115 60 59.1 Fairfax Granitevle 1950-51 30	Stvns Cr.-Granitevle 115 60 14.5 Stevens Cr. Granitevle 1946-47 30	Stvns Cr.-McCrmk 115 60 26.97 Stevens Cr. McCrmk 1952-53 60	St. George-Charleston 115 60 46.7 St. George Charleston 1941 45	Charleston-Yemassee 115 60 57.88 Charleston Yemassee 1948 30	Yemassee-Fairfax 115 60 30.8 Yemassee Fairfax 1950 30	No. 17 115 60 3.5 Lyles S. S. Coit Sub. 1949 50	Jasper-Quincy 110 60 101.88 Jasper Quincy 1951 30	Turner-Woodmere 110 60 28.6 Turner Sta. Woodmere 1952 60	Higgins-Ft. Meade 110 60 75.2 Higgins Sta. Ft. Meade 1952 45
W 6.48 H (W-10) 295 1 W (spar) .... W (700)	S 8 Sq. 335 (wet) 2 S S 4-tons	W 9 H 335 (wet) 1 (I), 1 (P) W W 600 W	W 8 H 335 (wet) 1 (I), 1 (P) W W 5,000 W	W 6.4 H 295 1 W None 7,000 None	W 6.4 H 295 1 W None 7,000 None	W 7 H 295 1 W None 7,000 None	W 8 H 295 1 W None 7,000 None	W 6.5 H 295 1 W None 7,000 None	W 7 H 295 1 W None 7,000 None	S(2 mi)-W(1.5 mi) 17, 10 S, H 295 1 S & W None 5,000-6,500 None	W 6.38 H (W-4) 295 1 W W ..... W 997)	W 8.08 H (W-2) 295 1 W W ..... W (997)	S 5.19 S (S-12 Vert.) 490 (I)-1, (P)-2 S S 12,930 None
ACSR 397,500 26 al./7 stl. 0.5472 ..... H ..... 14 815 1,760 16½ 2,766 24 (120F) 6½ Rods Stockbridge DE Only 110 to 495 Negligible	ACSR 336,400 26/7 0.46 ..... V 3 10 ..... 1,000 ..... 5,000 ..... 4 Tapered Stockbridge 10 to 50 0.1	ACSR 477,000 26/7 0.66 ..... H ..... 15¾ 560 1,000 ..... 6,200 ..... 4 Tapered Stockbridge 20 to 350 0.1	ACSR 4/0 7 0.29 ..... H ..... 15¾ 700 1,300 ..... 7,000 lbs. ..... 4 Tapered ..... 0 to 50	ACSR 336,400 26/7 0.462 350 H ..... 16 825 1,740 60 2,850 27 8 None Stockbridge 90 to 510	ACSR 266,800 26/7 0.365 300 H ..... 16 835 1,600 50 2,200 27 8 None Stockbridge 210 to 350	ACSR 336,400-477,000 26/7 0.462 0.655 350 H ..... 16 795 710 1,300 1,600 36 58(120F) 2,550 3,625 27 8 None Stockbridge 210 to 526	C Cw 3/0 6/1 0.563 300 H ..... 16 675 1,075 36.2 (120F) 2,300 27 8 None ..... 10 to 100	ACSR 366,400 26/7 0.462 350 H ..... 16 820 1,100 25 (120F) 2,675 27 8 None Stockbridge 0 to 50	ACSR 336,400 26/7 0.462 350 H ..... 16 750 1,025 35 (120F) 2200 27 8 None Stockbridge 69 to 155	ACSR 4/0 6/1 0.292 250 V H None ..... 10 14 330 590 590 665 9.5 11.5 (120F) 1,150-1,200 25 4 Taprd rods None 150 to 175	ACSR 4/0 6/1 0.292 340 H ..... 14 825 1,770 13.84 1,800 28 6.5 Taprd rods Stockbridge 48 to 248 0.1	C 4/0 7 0.653 484 H ..... 14 675 1,000 16.33 2,289 22 6.75 None Stockbridge 57 to 111 0.1	C 4/0 7 0.653 484 V 1.0 14 1,100 1,187 43.92 2,289 28 6.33 None None 2 to 202 0.1
1,300 D 7 x 10 D 9 x 10 D 7 x 10 750 550	760 D 9 x 80/50 D 10 x 80/50 Pedestal 4 550	2,000 D 8 x 80/50 D 9 x 80/50 Pedestal 3 550	2,000 D 8 x 80/50 D 9 x 80/50 Pedestal 3 550	1,140 D 7 x 10 D 13 D 13 None 550	1,140 D 7 x 10 D 13 D 13 None 550	1,140 D 7 x 10 D 13 D 13 None 550	1,140 D 7 x 10 D 13 D 13 None 550	1,140 D 7 x 10 D 13 D 13 None 550	1,140 D 7 x 10 D 13 D 13 None 550	695 D 7 x 10 D 7 D 9 None 550	1,215 D 7 x 5.75 x 695 D 9 x 5.75 x 860 D 11x5.75x1,025 550	1,262 D 7 x 5.75 x 695 D 9 x 5.75 x 860 D 11x5.75x1,025 550	1,105 D 12x5.75x1,105 D 12x5.75x1,105 D 11x5.75x1,025 550
2 ⅝ St 28 18¾ 2 to 15 C S ..... Sub. Sta. 121 ..... None None None Dist. 5 One Shot	2 7/16 E.H.S.St 40 12 to 20 3 to 50 ..... S .... Dist. Carr 5 20	2 ⅝ H. S. St 50 12 to 20 25 to 500 ..... S .... Dist. Carr. 5 20	.... S .... OC 5 20	2 5/16 St 35 14 (min.) 5 to 850 L S ..... 121 ..... None None None Dist. 5 No reclo.	2 5/16 St 35 14 (min.) 0.5 to 300 None S ..... 110 & 121 ..... None None None Dist. 20 No reclo.	2 ⅝ St 35 14 (min.) 0.5 to 12.0 L S ..... 110 & 121 ..... None None None Dist. 5 No reclo.	2 5/16 St 35 14 2 to 80 None S ..... 121 ..... None None None Dist. 5 No reclo.	2 5/16 St 35 14 0.5 to 200 None S ..... 121 ..... None None None Dist. 5 No reclo.	2 5/16 St 35 14 2 to 15 L S ..... 121 ..... None None None Dist. 5 No reclo.	2 5/16 St 38 10 ..... C S ..... 97 ..... None None None Dist 5 No reclo.	2 ⅝ St 32.83 14.42 5 to 10 None S ..... 97 ..... None None None Ph. Z; Cur. Dir. Gnd 5 300	2 ⅝ St 25.5 19.91 5 to 10 None S ..... 97 ..... None None None Ph. Z; Cur. Dir. Gnd. 5 300	2 ⅝ Cw 0 29.25 5 to 10 None S ..... 97 ..... None None None Ph. Z; Cur. Dir. Gnd. 5 300
.... None .... None Rel, Tel, Comm 72 None None	..... None .... None Rel, Tel, Comm 72 None None	..... None .... None Rel, Tel, Comm 72 None None	.... None	..... None ..... None ..... None None 50-150 None None	..... None ..... None ..... None None 50-150 None None	..... None ..... None ..... None None 50-150 None None	..... None ..... None ..... None None 50-150 None None	..... None ..... None ..... None None 50-150 None None	..... None ..... None ..... None None 50-150 None None	..... None ..... None ..... None None None None None	..... None ..... None ..... None None 58 72.3 (Telem.) None None	..... None ..... None ..... None None 66 Pendg. (Telem.) None None	..... None ..... None ..... None None 75 Pendg. (Telem.) None None

Characteristics of Typical Modern Transmission Lines in the

Region	EAST SOUTH CENTRAL										
Company	Memphis Light Gas & Water Division		Alabama Power Co								
Line designation (Name or No.)	.....	.....	3,724	3,725	3,736	3,737	3,742	3,739	3,752	3,753	3,755
Voltage (nominal)-kv	115	115	110	110	110	110	110	110	110	110	110
Frequency-cps	60	60	60	60	60	60	60	60	60	60	60
Length of line-miles	4	22	16.83	37.2	8.8	48.23	17.32	17.33	53	16.8	44.35
Originates at	Old T.V.A. Line	Memphis	Jordan Dam	S. Mntgmry	Fulton Spgs.	Bessemer	Gorgas	Gorgas	Thurlow Dam	Pinkard	Eutaula
Terminates at	Millington	Millington	North Mntgmry	Union Springs	Pratt City	Tuscaloosa	Fairfield	Fairfield	Phenix City	Webb	Webb
Year of constr. (or recons.)	1943	1947–51–52	1949	1949	1941	1948	1943	1950	1946	1950	1951
Rating per cct. Mva	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
STRUCTURES											
(S)teel, (W)ood, (A)lum.	W	W	W	W	W	W	W	W	W	W	W
Av. No. per mile	9	9	6.8	6.6	11	6.55	7	6.2	6.1	6.6	6.66
Types (S)q, (A)-or (H)-frame*	H (W-10)	H(W-10), S	H (W-10)	H (W-10)	A (guyed)	H (W-10)	H (W-10)	H (W-10)	H (W-10)	H (W-10)	H (W-10)
Min. flashover-60 cps kv	.....	.....	485	485	485	485	485	485	485	485	485
No. of circ. (D)nst. (P)rov.	1	1	1	1	2	1	1	1	1	1	1
Crossarms, (W)ood, (S)teel, (A)lum	W	W	W	W	W	W	W	W	W	W	W
Bracing (S)teel, (W)ood	W	W	.....	.....	.....	.....	.....	.....	.....	.....	.....
Av. weight per struc.-lb	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Insul. in guys (W)ood, (P)orc.-kv	.....	.....	None	None	None	None	None	None	None	None	None
CONDUCTORS											
C, A, S, ACSR, Cw, (H)ollow	C	ACSR	ACSR	ACSR	C	ACSR	C	ACSR	ACSR	ACSR	ACSR
Diam, cir mil or gage	4/0	266,800	397,500	397,500	4/0	397,500	250,000	556,600	397,500	266,800	266,800
Stranding	7	26/7	26/7	26/7	7	26/7	19	26/7	26/7	26/7	26/7
Weight per ft-lb	0.656	0.366	0.5464	0.5464	0.653	0.5464	0.774	0.765	0.5464	0.3656	0.3656
Designed for —— amp.	.....	.....	590	590	480	590	540	730	590	460	460
Ph. config. (V)ert, (H)or, (T)riang.	H	H	H	H	V	H	H	H	H	H	H
Cond. offset from vert.-ft	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....
Phase separation-ft	12.5	12.5	15.5	15.5	10.6	15.5	15.5	15.5	15.5	15.5	15.5
Span, normal-ft	600	600	771	800	500	815	750	850	840	800	805
Span, max.-ft	650	1,000	1,150	1,595	1,145	2,000	2,160	2,064	1,650	1,300	1,500
Sag final-ft at deg F	13.6 (60F)	8.25 (60F)	10.5 (60F)	11.5 (60F)	11.9 (60F)	11.3 (60F)	13 (60F)	13 (60F)	12.5 (60F)	10.2 (60F)	10.6 (60F)
Tension corresponding	2,150	2,620	3,750	3,750	2,350	3,859	2,760	5,320	3,815	3,434	2,760
Min. clear. to ground-ft	22	27.5	25	25	25	25	25	25	25	25	25
Min. clear. to struct-ft	3.5	3.5	7.5	7.5	6.5	7.5	7.5	7.5	7.5	7.5	7.5
Type armor at clamps	None	Al Rods	.....	.....	.....	.....	.....	.....	.....	.....	.....
Type vibration dampers	None	None	Stockbridge	Stockbridge	.....	Stockbridge	.....	.....	Stockbridge	Stockbridge	Stockbridge
Line altitude range-ft	300	200 to 300	25 to 750	25 to 750	25 to 750	25 to 750	25 to 750	25 to 750	25 to 750	25 to 750	25 to 750
Max. corona loss-kw/3-ph. mile	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
INSULATION											
Basic imp. insul. level-kv	550	550	485	485	485	485	485	485	485	485	485
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	7	7	8	8	8	8	8	8	8	8	8
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	9	9	14	14	14	14	14	14	14	14	14
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	9	9	14	14	14	14	14	14	14	14	14
Impulse reduction-kv or %	.....	.....	75	75	75	75	75	75	75	75	75
BIL of term. apparatus-kv	550	550	550	550	550	550	550	550	550	550	550
IMPULSE SURGE PROTECTION											
No. of ground wires	2	2	2	2	2	2	2	2	2	2	2
Grd. wire matl. and size	7/16 EHS Cw	3 No. 6 EHS Cw	3/8 HS St	3/8 HS St	3/8 HS St	3/8 HS St	3/8 HS St	3/8 HS St	3/8 HS St	3/8 HS St	3/8 HS St
Cone angle of prot-deg	30	30	35	35	10	35	35	35	35	35	35
Grd. wire clear., mid-span-ft	14.8	13.5	16	16.2	18	16.2	21	18.4	16	15	15
Grd. res. range-ohms	30	30	1–15	1–15	1–14	3–17	1–15	1–15	2–17	8–15	3–15
Counterpoise (L)inear, (C)rowfoot	None	None	C	C	C	C	C	C	C	C	C
Neut.gdg.(S)olid, (R), (X), (T)ransf.	S	S	S	S	S	S	S	S	S	S	S
Neut. gdg.-equiv. ohms	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arrester rating-kv	97	97	97	97	97	97	97	97	97	97–122	97–122
Expulsion tube gap-in	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arcing horn gap-in	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arcing ring top diam-in	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arcing ring bot. diam-in	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Type relaying	.....	.....	Dir. & Dist.	Dir. & Dist.	Dir. & Dist.	Dir. & Dist.	Dir. & Dist.	Dir. & Dist.	Dir. & Dist.	Dir. & Dist.	Dir. & Dist.
Breaker interruption-cycles	5	5	5 to 12	5 to 8	5 to 8	8 to 12	5 to 8	5 to 8	12	5 to 8	5 to 8
Reclosure delay-cycles	None	None	300	300	180	300	300	300	.....	300	300
VOLTAGE REGULATION											
Nominal-%	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Synch. cond.-kva	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Synch. cond. spacing-miles	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shunt cap.-kva	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shunt cap. spacing-miles	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Series capacitor-kva	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
COMMUNICATION											
Telep circ on struct.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Carrier frequency-kc	.....	.....	180	.....	.....	55	93	.....	.....	.....	.....
Pilot wire	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Microwave-Mc	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Parentheses refer to configuration diagrams on page 150

United States

100-130 kv

EAST SOUTH CENTRAL

		Mississippi Power & Light Co		Mississippi Power Co		
.....	3,747	Greenville-N. Jackson	DSES-Greenwood	Hattiesburg-Meridian	Gulfport-Hattiesburg	NewOrleans-Gulfport
110	110	115	115	110	110	110
60	60	60	60	60	60	60
31.5	5.8 (W) & 0.35 (S)	97.57	40	104.65	68.24	36.25
Thurlow Dam	Chickasaw	Rex Brown Sta.	Delta Sta.	Hburg SS	Glfprt SS	Glfprt SS
Union Sprgs.	Blakeley Is.	Greenville	Greenwood	Meridian	Hburg S	La.-Miss. St. Line
1952	1950	1946	1953	1950 (N)	1940 (N)	1942 (N)
.....	.....	46	70	60	60	50
W	W & S	W	W	W	W	W
6.1	10.7	8.92	9.6	6.6	6.15	7
H (W-10)	H (W-10)	H (W-10)	H (W-10)	H (W-10)	H (W-10)	H (W-10)
485	485	695 (ins. only)	695 (ins. only)	.....	.....	.....
1	1	1	1	1	1	1
W	W & S	W	W	W	W	W
.....	.....	W	W	St guy	St guy	St guy
.....	.....	6,000	6,000	.....	.....	.....
None	.....	None	None	None	None	None
ACSR	C	ACSR	ACSR	ACSR	ACSR	CCw
397,500	250,000	336,400	666,600	266,800	266,800	3/0
26/7	19	26/7	24/7	26/7	26/7	7 Str
0.5464	0.774	0.463	0.857	0.368	0.368	0.563
590	540	530	800	460	460	410
H	H	H	H	H	H	H
.....	.....	.....	.....	.....	.....	.....
15.5	15.5	14	14	16	16	16
870	490	600	600	795	865	725
1.485	850	1,225	1,000	1,650	1,420	1,000
13.5 (60F)	8.3 (60F)	9 (60F, 600 ft)	9 (60F, 600 ft)	10.4 (60F)	12.6 (60F)	14.4 (60F)
3,880	2,900	2,270	4,324	3,000	4,420	4,260
25	25	26	26	28	28	28
7.5	7.5	6	6	8	8	7.5
.....	.....	Taprd (Al)	Taprd (Al)	.....	.....	.....
Stockbridge	.....	None	None	Stockbridge	Stockbridge	.....
25 to 750	25 to 750	200 to 300	100 to 300	164 to 666	2 to 41	2 to 12
.....	.....	0.09	0.04	.....	.....	.....
485	485	1,100	1,100	800	800	800
D	D	D	D	D	D	D
8	8/12	6 x 695	6 x 695	7 x 50	7 x 50	7 x 50
D	D	D	D (Dbl Str)	D	D	D
14	14/14	12 x 1,105	12 x 1,105	8 x 50	8 x 50	8 x 50
D	D	D	D	D	D	D
14	14/14	9 x 860	9 x 860	13 x 50	13 x 50	13 x 50
75	75	20 in. gap	20 in. gap	None	None	None
550	550	550	550	550	550	550
2	2	2	2	2	2	2
3/8 HS St	3/8 HS St	3/8 DGHS	5/16 DGHS	5/16 Steel	3/8 Galv. St	5/16Galv.St
35	35	30	30	80	80	75
16	16.7	13	13	11.3	13.7	16.7
1-17	1-15	0.3-17.0	0.3-25.0	15 (max)	15 (max)	15 (max)
C	C	.....	.....	C	C	C
S	S	S	S	S	S	S
.....	.....	None	None	3 (max)	3 (max)	3 (max)
97	97	(12 in. gap fuses)	(12 in. gap fuses)	97	97	97
.....	.....	None	None	.....	.....	.....
.....	.....	20	20	28	28	28
.....	.....	None	None	None	None	None
.....	.....	None	None	None	None	None
Dir. & Dist.	Dir. & Dist.	Dist. (GCY)	Dist. (GCY)	Dir. Dist.	Dir. Dist.	Dir. Dist.
5 to 8	5 to 8	5	5	1½	1½	1½
300	300	60	60	5	5	5
.....	.....	5	5	.....	.....	.....
.....	.....	None	None	None	None	None
.....	.....	None	None	None	None	None
.....	.....	None	None	None	None	None
.....	.....	None	None	None	None	None
.....	.....	None	None	None	None	None
.....	.....	None	None	.....	.....	None
.....	.....	136	70	67	67	.....
.....	Yes	None	None	.....	.....	None
.....	.....	None	None	.....	.....	None

WEST SOUTH CENTRAL

	Arkansas-Missouri Power Co			New Orleans Public Service, Inc		
	APL-Jim Hill	Jim Hill-Hayti	Hayti-Blytheville	96 & 97	91 & 93	94
	115	115	115	115	115	115
	60	60	60	60	60	60
	26.3	26.7	26.4	12.50 (both)	12.78 (both)	17.91
	Gr.-Craigh'd Cnty Line, Ark.	Jim Hill Sta.	Hayti	New Orleans	New Orleans	New Orleans
	Jim Hill Sta.	Hayti	Blytheville	New Orleans	New Orleans	New Orleans
	1945-1947	1947-1948	1948-1949	1952	1942 & 1947	1942
	40	40	40	114	80	80
	W	W	W	W	S	W
	8	8	7	30	5.4	10.5
	H (W-10)	H (W-10)	H (W-10)	(W-24)	S	H
	605	590	590	335	375	335
	1	1	1	1	1 & 2	1
	W	W	W	W	S	W
	W	W	W	.....	.....	W
	.....	.....	.....	.....	.....	.....
	None	None	None	None	None	None
	ACSR	ACSR	ACSR	C	CCw	C
	336,400	336,400	336,400	300,000	293,000 Equ.	4/0
	26/7	26/7	26/7	19	19	12
	0.463	0.463	0.463	0.9263	1.177	0.653
	200	200	200	570	400	400
	H	H	H	V	V	H
	.....	.....	.....	.....	3.3	.....
	14.5	14.5	14.5	9	13	14
	650	650	720	175	975	500
	1,150	750	760	309	1,958	829
	9.5 (60F)	9.5 (60F)	11.5 (60F)	7.7 (60F, max)	90.3 (60F, max)	25.1 (60F, max)
	2,600	2,600	2,600	1,454	6,400	2,370
	22	22	24	44	58	31
	7	7	7	4 (no wind)	5.13 (no wind)	4 (no wind)
	Al Rod	Al Rod	Al Rod	None	None	None
	None	.....	.....	None	None	None
	280 to 400	270 to 280	250 to 270	−3.0 to +20.0	−3.0 to +20.0	−3.0 to +20.0
	0.1	0.1	0.1	.....	.....	.....
	1,355	1,320	1,320	920 (min)	945 (min)	990 (min)
	D	D	D	D	D	D
	7 x 295	6 x 255	6 x 255	8 x 780	10 x 945	8 x 780
	D	D	D	D	D	D
	9 x 375	9 x 375	9 x 375	13 x 1,185	12 x 1,105	12 x 1,105
	D	D	D	D	D	D
	9 x 375	9 x 375	9 x 375	13 x 1,185	12 x 1,105	14 x 1,265
	.....	.....	.....	.....	.....	.....
	550	550	550	550	550	550
	2	2	2	1	1 & 2	2
	No. 4 BWG Iron	No. 4 BWG Iron	No. 4 BWG Iron	3/8 Cw & 3/8 S	3/8 Cw	3/8 Cw
	30	30	30	34½	18	29.7
	11+ above cond.	11+ above cond.	11+ above cond.	10.13 (ave. span, 60 F, no wind)	24.8 (ave. span, 60 F, no wind)	24.3 (ave. span, 60 F, no wind)
	2-80	2-80	2-80	4 to 6	0.25 to 0.75	1 to 2
	None	None	None	.....	.....	.....
	8	8	S	S	S	S
	10	10	10	.....	.....	.....
	None	None	None	97	97	97
	None	None	None	.....	.....	.....
	None	None	None	.....	.....	.....
	None	None	None	.....	.....	.....
	None	None	None	.....	.....	.....
	HM, GCX: CR, ICC Gnd.	HM, GCX: CR, ICC Gnd.	HM, GCX: CR, ICC Gnd.	Pilot Wire	Pilot Wire	Carr. Dist.
	5-8	5-8	5-8	5	5	5
	None	None	None	0	0	0
	5	5	5	Negligible	Negligible	Negligible
	None	None	None	.....	.....	.....
	None	None	None	.....	.....	.....
	None	None	None	.....	.....	.....
	None	None	None	.....	.....	.....
	None	None	None	.....	.....	.....
	None	None	None	.....	.....	.....
	114-191	149, 189	149, 189	50 to 150	.....	50 to 150
	None	None	None	Yes	Yes	.....
	None	None	None	.....	.....	.....

Characteristics of Typical Modern Transmission Lines in the

Region	WEST SOUTH CENTRAL						MOUNTAIN				
Company	Louisiana Power & Light Co			S'western Gas & Elec Co	Southwestern Public Service Co		Bureau of Reclamation	Public Service of Colorado			Sierra Pacific Power Co
Line designation (Name or No.)	Minden-Arkansas	Sterl'gton-Red Gum	Standard-Beaver Crk	In Ark. 172 In Okla. 251	Denver City-Carlsbad	Plant X-Tuco	Typical line	Arapahoe-Leetsdale	Arsenal-Leetsdale	Leadville-Poncha	50
Voltage (nominal)-kv	110	110	110	115	115	115	115	115	115	115	120
Frequency-cps	60	60	60	60	60	60	60	60	60	60	60
Length of line-miles	32	82.5	34.8	41.1	118.8	46	.....	17.9	20.35	57.04	29.5
Originates at	Minden	Sterl'gton	Standard	Siloam Spgs. Ark.	Denver City Sta.	Sta. X	.....	Arapahoe-Stm. Sta.	Leetsdale Sta.	Leadville Sta.	Donner Summit
Terminates at	Ark. State Line	Ferriday	Simms	Markhams Ferry	Carlsbad Sta.	Tuco Sta.	.....	Leetsdale Sta.	Arsenal Sta.	Poncha Junct. Sta.	California Sta.
Year of constr. (or recons)	1952	1948	1940	1950	1946	1952	.....	1950	1948	1947	1949
Rating per cct.-Mva	65	50	50	30	30	62.5	.....	50	30	20	45
STRUCTURES											
(S)teel, (W)ood, (A)lum.	W	W	W	W	W	W	W	S	W	W	W
Av. No. per mile	10	10	10	8.1	9	7.5	8	7.4	8.6	7.14	9
Types (S)q, (A)-or (H)-frame*	H (W-10)	H (W-10)	H (W-10)	H (W-6)	H (W-11)	H (W-11)	H (W-4)	S (S-3)	H (W-4)	H (W-6)	H (W-1)
Min. flashover-60 cps. kv	450	450	450	295	440	440	295	250	250	250	.....
No. of cir. (I)nst. (P)rov	1	1	1	1	1	1	1	2	1	1	1
Crossarms, (W)ood, (S)teel, (A)lum.	W	W	W	W	W	W	W	S	W	W	S
Bracing, (S)teel, (W)ood	W	None	None	W	W	W	W	None	None	None	W
Av. weight per struc.-lb	.....	.....	.....	5,225	.....	.....	6,000	8,430	.....	.....	.....
Insul. in guys (W)ood, (P)orc.-kv	None	None	None	W	W (115)	W (115)	None	.....	W	W	None
CONDUCTORS											
C, A, S, ACSR, Cw, (H)ollow	ACSR	ACSR	HC	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	Cw
Diam. cir mil or gage	666,600	336,400	No. 923	4/0	4/0	397,500	397,500	336,400	266,800	4/0	4/0
Stranding	26/7	26/7	18	6/1	6/1	26/7	26/7	30/7	26/7	6/1	7
Weight per ft-lb	0.858	0.462	0.668	0.291	0.28	0.62	0.5464	0.526	0.366	0.292	.....
Designed for ___amp	530	350	350	300	150	314	.....	325	275	225	.....
Ph. config. (V)ert, (H)or, (T)riang	H	H	H	H	H	H	H	V	H	H	H
Cond. offset from vert.-ft	.....	.....	.....	None	.....	.....	.....	2½	.....	.....	.....
Phase separation-ft	14	14	14	14	12.5	12.5	12	12	12.5	12.5	12.5
Span, normal-ft	600	600	600	640	587	705	700	716	612	740	600
Span, max.-ft	1,000	850	800	1,186	700	800	2,100	1,327	862	1,780	1,180
Sag final-ft at deg F	9.5 (70F)	8.5 (70F)	13.4 (70F)	13.8	10.8 (60F)	16 (60F)	11.9 (60F)	13.7 (60F)	10.7 (60F)	16 (60F)	64.5 (60F)
Tension corresponding	4,109	2,440	2,267	1,055	1,200	2,300	2,840	2,440	1,590	1,350	50% (HL)
Min. clear. to ground-ft	26	26	25	24	25	25	27	35	32	28	31
Min. clear. to struct-ft	6	6	6	6.5	5.5	5.5	3.67	4	4	4	5.5
Type armor at clamps	Alum.	Alum.	Alum.	None	Tapered	Preformed	Tapered	Tapered	Tapered	Tapered	None
Type vibration dampers	None	None	None	None	None	None	Stockbridge	None	None	None	None
Line altitude range-ft	250	150	150	565 to 1,160	3,523 to 3,109	3,669 to 3,397	.....	5,280	5,280	7,550 to 10,300	5,000 to 7,200
Max. corona loss-kw/3-ph. mile	0	0	0	0.15	0.1	0.1 (max)	0.27 (4,000 ft fair wea.)	0.07	0.08	0.1	.....
INSULATION											
Basic imp. insul. level-kv	1,300	1,300	1,300	695 to 945	1,040	1,040	995 (crit. pos.)	630	1,150	1,150	.....
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	6 x 600	6 x 600	6 x 600	7	7 x 5.75	7 x 5.75	7 x 435	7	7	7	7
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	12 x 1,200	12 x 1,200	10 x 1,000	8	8 x 5.75	9 x 5.75	9 x 540 (dry)	8	8	8	8
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	12 x 1,200	12 x 1,200	14 x 1,400	9	8 x 5.75	9 x 5.75	9 x 54 (dry)	8	8	8	8
Impulse reduction-kv or %	6	.....	.....	.....	None	None	.....	80	600	600	.....
BIL of term. apparatus-kv	550	550	550	550	550	550	.....	550	550	550	.....
IMPULSE SURGE PROTECTION											
No. of ground wires	2	2	2	2	2	2	1	1	2	None	None
Grd. wire matl. and size	⅜-30% Cw	⅜-30% Cw	⅜-30% Cw	⅜ H.S. St.	7/16 EHS Galv. St.	7/16 EHS Galv. St.	⅜ H.S. St.	⅜ H.S. St.	⅜ H.S. St.	None	.....
Cone angle of prot-deg	31	31	32	30	30	30	30	45	36½	None	.....
Grd. wire clear., mid-span-ft	9	9	7	18	13½ (appx)	15 (appx)	16 (vert)	12½ (vert)	12½ (vert)	None	.....
Grd. res. range-ohms	100	50	150	10 to 800	5 to 300	10 to 100	5 to 20	0.57 to 3.1	0.3 to 6.0	0.7 to 7.5	.....
Counterpoise (L)inear, (C)rowfoot	None	None	None	None	None	None	None	None	None	None	.....
Neut. grd. (S)olid, (R), (X), (T)ransf	S	S	S	S	S	S	S	S	S	Petersen Coil	S
Neut. gdg.-equiv. ohms	0	0	0	.....	.....	.....	.....	0.5 (max)	0.5 (max)	338 (react.)	.....
Arrester rating-kv	None	None	None	97	97	97	.....	97	97	.....	115 (grdd)
Explusion tube gap-in	None	None	None	None	None	None	None	None	None	13 (extern.)	.....
Arcing horn gap-in	22	22	22	None	None	None	None	44	44	44	.....
Arcing ring top diam-in	.....	None	None	None	None	None	None	None	None	None	.....
Arcing ring bot. diam.-in	.....	None	None	None	None	None	None	None	None	None	.....
Type relaying	Imp. Carr.	Imp. Carr.	OC	Imp.	Dist. Carr.	Dist. Carr.	Dist. & OC	Imp. & OC pil. wire	Imp. & carr.	Imp. (HZ)	OC, RP & Resid.
Breaker interruption-cycles	5	5	5	5	3	3	5	7	7	5	5
Reclosure delay-cycles	Inst. to 20	Inst. to 20	Inst. to 20	300	20	20	20	None	None	None	Manual
VOLTAGE REGULATION											
Nominal-%	.....	.....	.....	4	5	5	+5, −10	4	4	10	7
Synch. cond.-kva	.....	.....	.....	None	None	None	.....	None	None	None	None
Synch. cond. spacing-miles	.....	.....	.....	None	None	None	.....	None	None	None	.....
Shunt cap.-kva	.....	.....	.....	None	None	None	.....	None	None	None	None
Shunt cap. spacing-miles	.....	.....	.....	None	None	None	.....	None	None	None	.....
Series capacitor-kva	.....	.....	.....	None	None	None	.....	None	None	None	None
COMMUNICATION											
Telep circ on struct	.....	.....	.....	None	None	None	None	Bell Phone	Bell Phone	.....	None
Carrier frequency-kc	.....	55 & 123	None	None	50 to 150	50 to 150	30 & 215	None	None	93.5	.....
Pilot wire	.....	.....	.....	None	None	None	1 Inst. only	None	None	None	.....
Microwave-Mc	.....	.....	.....	None	None	None	None	None	None	None	.....

* Parentheses refer to configuration diagrams on page 150

United States

100-130 kv

PACIFIC

Pacific Gas & Elec Co	San Diego Gas & Elec Co	Washington Water Power Co		City of Tacoma Dept. of L.	City of Seattle Dept of Lighting		Portland Gen. Elec Co	California Oregon Power Co			Pacific Power & Light Co	
Cortino-Mendocino	Chino-San Diego	Steptoe	Cabinet	Nisqually-Transmission	Bothell No. 1 Ross-Gorge	North-Broad	115,001	39	40	46	Merwin-Yale Merwin Kala.	Un. Gap-Pac. Pac.-Riv. Rd.
110	115	110	110	115	115	115	115	120	120	120	115	115
60	60	60	60	60	60	60	60	60	60	60	60	60
60.7	63.066	52.8	32.2	31.4	9.04	5.06	7.67	49.14	45	45	27	7
Cortino Sta.	Mission SS	Spokane	Sandpoint	La Grande	Bothell Sta.	North Sta.	Tape- St. Johns-Ore.C	Toketee	Days Creek	Soda Spg.	Yale	Union Gap
Mendocino Sta.	Capistrano Sta.	Colfax	Cabinet Gorge	Tacoma	8th N.E. & E. 183rd	Broad St. Sta.	Sta. E	Dixonville	Grants Pass	Dixonville	Kalama R.	River Rd. SS
1951	1940	1950	1951	1950	1951	1951	1944	1949	1951	1952	1952	1951
45	60	80	40	57	90	90	62	60	60	70	180	92
S	W	W	W	S	S	W	W	W	W	W	W	W
4.9	7	7.35	12.1	5	7.8	25	118	6.25	6.05	6.25	7	17
S (S-2)	H (W-1)	H (W-1)	A	S	S (S-2)	A (W-18)	A	H (W-1)	S & H (W-1, 25)	H (W-1)	H (W-2)	(W-19)
.....	.....	.....	.....	295	295	255	225–400	435	435	435	255 (wet)	255 (wet)
2	1	1	1	2	2	1	1	1	1	1	1	1
S	W	W	W	S	S	W	W	S	S	S	W	W
None	W	.....	.....	S	S	.....	None	None	None	None	W	None
6,500	6,600	.....	.....	9,173	7,892	.....	2,400	.....	.....	.....	.....	.....
None	.....	None	None	None	None	.....	W (44)	None	None	None	None	W
ACSR	C	C	C	ACSR	ACSR	ACSR	C	C	ACSR	ACSR	ACSR	ACSR
397,500	250,000	250,000	2/0	556,500	477,000	477,000	350,000	250,000	397,500	795,000	795,000	266,800
26/7	19	19	7	26/7	26/7	26/7	19	19	26/7	26/7	26/7	26/7
0.546	0.7719	0.772	0.410	0.765	0.746	0.746	1.081	0.7719	0.5464	1.098	1.098	0.3656
.....	300	500	250	.....	600	600	.....	.....	.....	.....	900	450
V	H	H	H	V	V	T	T	H	H	H	H	T
2.5	.....	0	1	2	4.0	.....	1.25	.....	.....	.....	.....	0.5
10	12.7	10.5	9.83, 5.92	12	11.24	11.6	12.6 Equ.	12	12	12	11.75	10
1,000	750	600	450	1,160	850	210	240	848	800	750	800	300
2,650	1,912	1,598	785	1,775	1,545	.....	420	2,908	2,507	.....	1,910	350
24.3 (60F)	.....	12 (60F)	7 (60F)	28.5 (60F)	82 (100F)	.....	6.3 (60F)	22.6 (60F)	12.5 (60F)	18 (60F)	22.7 (60F)	2.4
1,985	2,973	2,840	1,400	4,470	2,730	.....	2,000	2,880	3,000	4,525	3,450	1,975
30	30	29	29	32	30	55	.....	28	28	28	30	48
2.5	6	2	2	8	2.5	2.5	2.25	2.5	2.5	2.5	3	3
Twisted rods	.....	None	None	Alum.	Tapered	None	None	None	Preformed	Preformed	Rods	Rods
Stockbridge	.....	None	None	None	None	None	None	None	None	None	None	None
150 to 3,123	68 to 900	1,800 to 2,600	2,050 to 2,500	70 to 940	100 to 300	100 to 200	30 to 470	625 to 3,260	800 to 2,900	625 to 3,260	50 to 2,000	980 to 1,067
Small	5	0.1	1.0	.....	1.0 (max)	1.0 (max)	0.1	.....	.....	.....	1.0 (max)	1.0 (max)
.....	.....	585	585	550	695	695	585 (guyed 225)	.....	.....	.....	.....	.....
D	D	D	D	D	D	D	D	D	D	D	D	D
8 x 5.75	10 x 80/50	6	6	7 x 115	7	6 x 80 (dry)	6 x 125	7 x 80	7 x 80	7 x 80	6 (Pos. 610, Neg. 585)	6 (Pos. 610, Neg. 685)
D	D	D	D	D	D	D	D	D	D	D	D	D
9 x 5.75	10 x 80/50	6	6	8 x 115	7	6 x 80 (dry)	7 x 125	7 x 80	7 x 80	2 x 7 x 80	7 (Pos. 695, Neg. 670)	7 (Pos. 695, Neg. 670)
D	D	D	D	D	D	D	D	D	D	D	D	D
9 x 5.75	10 x 80/50	6	6	8 x 115	7	6 x 80 (dry)	7 x 125	8 x 80	8 x 80	2 x 7 x 80	7 (Pos. 695, Neg. 670)	7 (Pos. 695, Neg. 670)
.....	.....	.....	.....	0	None (2)	None	None	.....	.....	.....	20-in. rod gaps at term.	20-in. rod gaps at term.
.....	.....	550	550	550	550	550	550	550	550	550	550	550
None	None	None	None	1	None	1	None	None	None	None	2 (½ mi. from term. pts.)	2 (½ mi. from term. pts.)
.....	.....	.....	.....	⅜- 7 Str. (mess.)	.....	½ Siemens-Martin	.....	.....	.....	.....	⅞ Guy Str.	⅞ Guy Str.
.....	.....	.....	.....	41	.....	30	.....	.....	.....	.....	Approx. 30	Approx. 30
.....	.....	.....	.....	12	.....	.....	0.3 to 1 (term.)	.....	.....	.....	12	12
None	.....	.....	.....	.....	None	None	None	.....	.....	.....	None	None
S	S	.....	.....	S	S	S	S	.....	.....	.....	S (both term)	S (remote from line)
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
None	115	.....	.....	95	97	97	97	110	110	110	None	None
None	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	None	None
None	31.5	18	18	.....	.....	.....	.....	.....	.....	.....	20-in. rod gap (term.)	20-in. rod gap (term.)
None	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	None	None
None	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	None	None
Imp. & Grd.	HKB & HZ	HZM Dist.	.....	Bal.	Imp.	Pilot Wiring	Dist. & Grd.	Imp.	Dir. OC	Imp.	Imp. (Ph.)& OC (grd)	Reac. (Ph)& OC (grd)
5	5	5	8	5	5	5	5	5	5	5	5	5
1,800	.....	15	15	.....	Prov. only	Prov. only	By oper.	20	20	20	Manual close	Manual close
.....	.....	11	7	5	.....	.....	1	10	10	10	.....	.....
.....	.....	None	None	20 Mva/cir.	45,000 (2 sta)	.....	10,000(term)	None	None	None	.....	.....
.....	.....	.....	.....	Terminal	.....	.....	.....	.....	.....	.....	.....	.....
None	.....	None	None	None	None	None	None	None	None	None	.....	.....
None	.....	.....	.....	None	.....	.....	.....	.....	.....	.....	.....	.....
None	.....	None	None	None	.....	None	None	None	None	None	.....	.....
None	.....	.....	.....	None	None	None	None	None	None	None	None	None
50 & 55	Tel.55 (Rec) 95 (Tr), Relay 130	0	0	75 (voice)	None	None	None	52 to 75, 62 to 88, & 100 to 140	None	None	None	None
None	.....	None	None	None	None	Yes	None	None	None	None	None	None
None	.....	None	None	None	1,860 & 1,940	None	None	None	None	None	None	None

131-150 kv Characteristics of Typical

Region	MIDDLE ATLANTIC									
Company	Public Service Electric and Gas Co			Phila. Electric Co	Penn. P & L Co	West Penn Power Co			American Gas and Electric Co	
Line designation (Name or No.)	Sewaren-Metuchen	Camden-Richmond	Trenton-Navy	A-130-27	Sunbury Hummelst'n	Butler-Karns City	Washington-Franklin	Charleroi-Allenport	Tan. Cr.-Madison	Portsmouth, Trenton O.
Voltage (nominal)-kv	132	132	132	132	132	132	132	132	138	138
Frequency-cps	60	60	60	60	60	60	60	60	60	60
Length of line-miles	6.655	1.866	9.201	5.9	48.8	15.64	17.54	4.023	82	99
Originates at	Sewaren Sta.	Camden SS	Trenton SS	Emilie, Pa.	Sunbury Sta.	Butler	Washington	Charleroi	Lawrenceb'g	Portsmouth; O.
Terminates at	Metuchen SS	Richmond Sta.	Navy Test Sta.	P.S.E. & G. Co.	Hummelst'n SS	Karns City	Franklin	Allenport	Anderson; Ind.	Trenton, O.
Year of Constr. (or recons.)	1949	1951	1951–1952	1951	1949–1951	1950	1952	1952	1950	1942
Rating per ckt.-Mva	195	195	125	185	60	50	50	50	100	65
STRUCTURES										
(S)teel, (W)ood, (A)lum	S	S	W	S	S & W	81-W 18-S	W	W	S	W
Av. No. per mile	5.7	6.4	10.6	7.1	8	6.64 6.0	6.61	6.46	5.5	7.4
Types (S)q, (A)-or (H)-frame*	S (S-12)	S (S-17)	H (W-5)	S (S-14)	S H (W-3)	H (W-4)	H (W-5)	H (W-5)	S (S-3)	H (W-5)
Min. flashover-60 cps kv	400	400	400	415	440 (dry) 305 (wet)	540	540	540	365 (wet)	365 (wet)
No. of circuits (I)nst. (P)rov	2	1	1	(I)-1 (P)-2	1	1	1	1	2	1
Crossarms, (W)ood, (S)teel, (A)lum	S	S	W	S	S, W	W, S	W	W	S	W
Bracing (S)teel, (W)ood	S	S	W	S	W	W, S	W	W	S	W
Av. weight per struc.-lb	31,395	14,800	16,000	13,250	.....	.....	.....	.....	18,000	.....
Insul. in guys (W)ood, (P)orc.-kv	No guys	No guys	None	.....	None	W	W	W	.....	None
CONDUCTORS										
C, A, S; ACSR, Cw, (H)ollow	ACSR	ACSR	ACSR	ACSR	C-Cw	ACSR	ACSR	ACSR	ACSR	ACSR
Diam; Cir mil or Gage	795,000	795,000	397,500	477,000	0.550	336,400	336,400	336,400	636,000	477,000
Stranding	54/7	54/7	30/7	30/7	6/1	26/7	26/7	26/7	26/7	26/7
Weight per ft-lb	1.026	1.026	0.7459	0.746	0.710	0.463	0.463	0.463	0.874	0.657
Designed for——amp	850	850	550	810	480	.....	.....	.....	750	620
Ph. config. (V)ert, (H)or, (T)riang	V	H	H	T	H	H, (V-3 mi)	H	H	V	H
Cond. offset from Vert.-ft	8.5	.....	.....	.....	.....	2.5	.....	.....	4	.....
Phase separation-ft	18	19	16	26	12	14.5	14.5	14.5	13.0	15.5
Span, normal-ft	1,000	1,000	500	1,000	700	600	600	600	1,000	800
Span, max.-ft	1,023	950	640	1,349	1,775 to 1,751	2,018	2,090	1,610	2,150	2,100
Sag final-ft at deg F	33.5 (120F)	33.5 (120F)	13 (120F)	20 (60F)	21.2 (120F)	118 (60F)	125 (60F)	70 (60F)	33 (120F, 1000 ft)	21 (120F, 800 ft)
Tension corresponding	3,860	3,860	1,509	4,690	2,050	2,050	2,075	2,100	3,600	2,500
Min. clear. to ground-ft	30	30	27	35	27	25	25	25	28	28
Min. clear. to struct-ft	3.5	3.5	3.5	5.5	5 (30° Sw'g)	5	5	5	4	4
Type armor at clamps	None	None	None	Taprd Rods	None	Rods	Rods	Rods	Alum. liners	Alum. liners
Type vibration dampers	Stockbridge	Stockbridge	Stockbridge	None	None	None	None	None	Stockbridge	Stockbridge
Line altitude range-ft	10 to 140	25 to 65	50 to 205	40 to 100	320 to 1,459	1,197 to 1,781	990 to 1,480	830 to 1,250	750 to 1,100	550 to 1,200
Max. corona loss-kw/3-ph. mile	0.1 (max)	0.1 (max)	0.1 (max)	0.1	not measured	.....	.....	.....	.....	.....
INSULATION										
Basic imp. insul. level-kv	650	650	650	945	940	1,300	1,300	1,300	865	865
Tangent, (D)isk, (P)in, (L)ine-post	D	D (fog)	D	D	D	D	D	D	D	D
No. units and kv rating (or in)	9 x 525	9 x 525	9 x 525	10 x 132	8	9	9	.....	10 x 365 wet	10 x 365 wet
Angles, (D)isk, (P)in, (L)ine-post	D	D (fog)	D	D (Dbl str.)	D	D	D	D	D	D
No. units and kv rating (or in.)	11 x 620	11 x 620	11 x 620	10 x 132	10	9	9	.....	10 x 365 wet	10 x 365 wet
Term. (D)isk, (P)in, (L)ine-post	D	D (fog)	D	D (Dbl str.)	Pedestal	D	D	D	D (Dbl str.)	D (Dbl str.)
No. units and kv rating (or in.)	11 x 620	11 x 620	11 x 620	12 x 132	3 x 550	11	11	.....	12 x 435 wet	12 x 435 wet
Impulse reduction-kv or %	10%	10%	10%	41.8	390	.....	.....	.....	.....	.....
BIL of term. apparatus-kv	650	650	650	550	550	650	550	650	550/650	550/650
IMPULSE SURGE PROTECTION										
No. of ground wires	2	2	2	2	2	2	2	2	1	2
Grd. wire matl. and size	190,000 ACSR	½ St.	134,600 ACSR	190,800 ACSR	11/32 EHS Cw	159,000 ACSR	17/64 St.	3 No. 6 EHW Cw	159,000 ACSR	⅜ St.
Angle of prot.-deg	9.5	30	26 & 29	9	30	25	25	25	40	30
Grd. wire clear.,mid-span-ft	20	20	15	12.5	12.5	14	14	14	31	17
Grd. res. range-ohms	3 to 8	3 to 8	5 to 25	6 to 50	10	.....	.....	.....	1 to 24	.....
Counterpoise (L)inear, (C)rowfoot	None	None	None	C	L	.....	.....	.....	None	None
Neut. gdg. (S)olid, (R), (X), (T)ransf	S	S	S	S	S	.....	.....	.....	S	S
Neut. gdg.-equiv. ohms	0	0	0	.....	.....	.....	.....	.....	.....	.....
Arrester rating-kv	None	None	None	.....	121	121	121	121	109	109
Expulsion tube gap-in	None	None	None	121 (transf)	None	None	None	None	None	None
Arcing horn gap-in	42	42	42	.....	None	None	None	None	.....	.....
Arcing ring top diam-in	30	30	Horns	.....	None	None	None	None	.....	.....
Arcing ring bot. diam-in	30	30	Horns	.....	None	None	None	None	.....	.....
Type relaying	Carr. Dir.	Microwave Dir.	Pilot Wire	Dir. Comp. Carr.	Over Cur.	Carr. Dir. OC (BU, PhQT)	Carr. Dir. OC (BU, PhQT)	BU, Ph(QT)	Carr. Dir. Comp.	Carr. Dir. Comp.
Breaker interruption-cycles	9	3	9	5	5	6	6	6	3	3
Reclosure delay-cycles	Manual	Manual	Manual	No Recls.	120–180	600	.....	.....	15	15
VOLTAGE REGULATION										
Nominal-%	3.5	1.5	6.5	4.5	6	.....	.....	.....	.....	.....
Synch. cond.-kva	None	None	None	.....	.....	.....	.....	.....	.....	.....
Synch. cond. spacing-miles	None	None	None	.....	.....	.....	.....	.....	.....	.....
Shunt cap.-kva	None	None	None	.....	.....	.....	.....	.....	.....	.....
Shunt cap. spacing-mi	None	None	None	.....	.....	.....	.....	.....	.....	.....
Series capacitor-kva	None	None	None	.....	.....	.....	.....	.....	.....	.....
COMMUNICATION										
Telep circ on struct	None	None	None	.....	None	.....	.....	.....	None	None
Carrier frequency-kc	130 (relay)	None	None	150	None	.....	.....	.....	30–200	30–200
Pilot wire	Remote trip	None	Line relay	.....	None	.....	.....	.....	.....	.....
Microwave-Mc	None	954	None	.....	None	.....	.....	.....	.....	.....

* Parentheses refer to configuration diagrams on page 150

Modern Transmission Lines in the U. S. ▶ 131-150 kv

EAST NORTH CENTRAL

The Cleveland Electric Illuminating Co		Ohio Edison Co			Toledo Edison Co	Columbus & Southern Ohio Electric Co						
3rd Avon Line	Eastlake Line	Roberts-Springfield	Cloverton-Barberton	Lowellville-Masury	Lemoyne-S-R	11	12	13	14	15	18	19
132	132	138	138	138	138	138	138	138	138	138	138	138
60	60	60	60	60	60	60	60	60	60	60	60	60
18	5	64.3	22.5	13.5	63.12	53.67	42.82	18.04	15.29	5.25	10.22	30.46
Avon Sta.	Eastlake Sta.	Marion	Massillon	Lowellville	Lemoyne SS	Poston Gen. Sta.	Poston Sta.	Ross SS	Circleville SS	Bixby SS	Harrison SS	Bixby SS
Fowles Sta.	Branch Tap	Springfield	Barberton	Masury	Stryker & Rich. SS	Bixby SS	Ross SS	Circleville SS	Harrison SS	Marion Rd. SS	Marion Rd. SS	Clinton SS
1949	1953	1952	1952	1951	1949	1945	1950	1951	1951	1948	1951	1952
112	206	.....	.....	.....	120	60	85	95	95	105	100	75
S	S	W	S	S	S	W	W	W	W	W & S	W & S	S & W
7.55	5.86	8	6	6	5.5	6	5	6	7	6, 7	7	17 pole 8Ha
S (S-3)	S (S-7)	H (W-10)	S (S-6)	S (S-6)	S (S-2)	H (W-5)	H (W-5)	H (W-5)	H (W-5)	H (W-5), S (S-14)	H (W-5), S (S-14)	S (S-14), H (W-22)
380	415	335 (wet)	415 (wet)	415 (wet)	375	600	500	700	600	600	600	600
2	2	1	(I)-1, (P)-2	(I)-1, (P)-2	(I)-1, (P)-2	1	1	1	1	1	1	1
S	S	W	S	S	S	W	W	W	W	W	W	W
S	S	W	S	S	S	W	W	W	W	W	W	W
8,050	11,500	5,100	10,400	9,200	9,890	8,000	9,500	10,000	9,500	9,500 (W)	10,000	4,500 & 9,000
No guys	No guys	W (800)	None	None	None	None	None	None	None	None	None	None
Cw	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR, Cw	ACSR	ACSR	ACSR	ACSR	ACSR	C, ACSR
4/0	795,000	336,400	605,000	477,000	336,400	336.4–636 Mcm-E 4/0	636,000	336,400	336,400	336,400	336,400	4/0–336,400
12	26/7	26/7	24/7	26/7	30/7	26/7–26/7–7/12	26/7	30/7	30/7	30/7	30/7	19–30/7
0.653	1.098	0.463	0.779	0.6566	0.527	0.463–0.875 0.848	0.875	0.463	0.463	0.463	0.463	0.653–0.463
499	900	615	900	775	530	480	760	530	530	530	530	480
V	V	H	V	V	V	H	H	H	H	H(W)-V(S)	H(W)-V(S)	T-H-V
3	2.5	.....	4	4	4	.....	.....	.....	.....	.....	.....	.....
13	13.5 & 15.0	15.5	13.25 & 11.5	13.25 & 11.5	13.6	15	14.5	14.5	15	14.5–18.0	14.5-18.0	15 x 10–14.5–13
700	900	660	880	880	970	817	960	844	720	750	710	300–619
1,200	1,500	1,290	1,333	1,168	1,392	2,379	3,455	1,435	1,224	1,052	1,280	446–1,201
20.5 (60F)	27 (60F)	14 (60F, 660 ft)	22.6 (60F, 880 ft)	24.9 (60F, 880 ft)	16 (60F)	.....	25.8	13.4	9.9	11.7	9.3	.....
4,500 (max)	9,000 (max)	1,800	3,400	2,530	3,880	.....	4,230	3,350	3,400	3,350	3,400	.....
30	30	25	25	25	30	31	31	31	30	31	31	31
4	4.5	5	5	5	3.6	5	4+	5	6	7	5	4.5
None	Preformed	P.F.T. Rods	P.F.T. Rods	P.F.T. Rods	Taprd Rods	Rods	None	Rods	Rods	Rods	Rods	None
None	Stockbridge	None	None	None	Stockbridge	Stockbridge	Stockbridge	None	None	Stockbridge	Stockbridge	Stockbridge
600 to 1,000	600 to 1,000	850 to 1,200	850 to 1,200	800 to 1,200	655 to 851	700 to 1,100	700 to 1,050	800 to 900	800 to 850	800	800	800
0.6	0.1 (max)	0.2	0.1	0.2	0	None	None	None	None	None	None	1.2
835	935	1,150	930	930	845	760	760	760	760	760	760	760
D	D	D	D	D	D	D	D	D	D	D	D	D
10 x 5.0	10 x 5.75	8 x 5.75	10 x 5.75	10 x 5.75	9 x 845	8 x 80	8 x 80	8 x 80	8 x 80	8 x 80	8 x 80	8 x 80
D	D	D	D	D	D	D	D	D	D	D	D	D
12 x 5.0	12 x 5.75	8 x 5.75	10 x 5.75	10 x 5.75	11 x 1,015	10 x 80	10 x 80	10 x 80	10 x 80	10 x 80	10 x 80	10 x 80
D	D	D	D	D	D	D	D	D	D	D	D	D
12 x 5.0	12 x 5.75	10 x 5.75	10 x 5.75	10 x 5.75	11 x 1,015	10 x 80	10 x 80	10 x 80	10 x 80	10 x 80	10 x 80	10 x 80
0	100	.....	.....	.....	34.9	.....	.....	.....	.....	.....	.....	.....
650	550	650	650	650	550	230	230	230	230	230	230	230
1	2	2	1	1	1	2	2	2	2	2	2	1–2
½ Cw	176,900 ACSR	⅝ St.	134,600 ACSR	134,600 ACSR	134,600 ACSR	3 No. 5, 7 No. 8 Cw	7 No. 8 Cw	3 No. 5 Cw	3 No. 5 Cw	3 No. 5 Cw	3 No. 5 Cw	3 No. 5 Cw
45	20	36	41.33	41.33	41	30	30	30	30	30	30	30
15	14.7	13.9	22	25	18.2	46	48.4	47.9	47	48	48	.....
5 (max)	5 (max)	10 (max)	10 (max)	10 (max)	1 to 45	5 to 300	5 to 300	5 to 200	3 to 50	20 to 100	20 to 100	20 to 150
None	None	None	None	None	None	None	None	None	None	None	None	None
S	S	S	S	S	S	S	S	S	S	S	S	S
None	None	.....	.....	.....	0	.....	.....	.....	.....	.....	.....	.....
121	109	121	121	121	121	109	109	109	109	109	109	109
None	None	None	None	None	None	.....	.....	.....	.....	.....	.....	.....
None	None	None	None	None	None	.....	.....	.....	.....	.....	.....	.....
None	None	None	None	None	None	.....	.....	.....	.....	.....	.....	.....
None	None	None	None	None	None	.....	.....	.....	.....	.....	.....	.....
Dist.	Dist.	Carr. Cur.	Carr. Cur.	Pilot Wire	Carr., Dir. Comp. X	Dir. Z Carr.	Dir. Z Carr.	Dir. Z Carr.	Dir. Z Carr.	Dir. Z Carr.	Dir. Z Carr.	Dir. Z Carr.
8	3	8	5	5	5	4	4	4	4	4	4	4
Manual	18 (future)	Inst.	Inst.	Inst.	22	17	17	17	17	17	17	17
.....	.....	1	3	1	10	10	10	10	10	10	10	10
None	None	None Assgn	None Assgn	None Assgn	None	.....	.....	.....	.....	.....	.....	.....
None	None	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
None	None	None Assgn	None Assgn	None Assgn	None	.....	.....	.....	.....	.....	.....	.....
None	None	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
None	None	None	None	None	None	.....	.....	.....	.....	.....	.....	.....
None	None	None	None	None	None	.....	.....	.....	.....	.....	.....	.....
None	None	115	None	None	102	65.5	65.5	65.5	65.5	65.5	65.5	65.5
None	None	None	None	None	None	.....	.....	.....	.....	.....	.....	.....
None	Future	None	None	None	None	.....	.....	.....	.....	.....	.....	.....

Characteristics of Typical Modern Transmission Lines in the

Region	EAST NORTH CENTRAL										
Company	**Columbus & So. Ohio Electric Co**			**The Cincinnati Gas & Electric Co**			**Indianapolis Power & Light Co**			**No. Indiana Public Service Co**	
Line designation (Name or No.)	21	23	24	883–884	3,881	3,885	132–18	132–23	132–22	13,803	13,803
Voltage (nominal)-kv	138	138	138	132	132	132	132	132	132	138	138
Frequency-cps	60	60	60	60	60	60	60	60	60	60	60
Length of line-miles	16.82	19.62	24.97	15.6	30.4	29.4	9	24.7	23.5	3.04	2.65
Originates at	Harrison SS	Ross SS	Pike SS	Beckjord Sta.	Beckjord Sta.	Miami Ft. Sta.	Harding St. Sta.	White R. Sta.	White R. Sta.	State Line Sta.	129th St. Jct.
Terminates at	Wilson Rd. SS	Waverly SS	Adams SS	Oakley SS	Port Union SS	Port Union SS	Southeast SS	Southwest SS	Harding St. Sta.	129th St. Jct.	Marktown
Year of constr. (recons.)	1953	1952	1953	1951	1951	1952	1931	1949	1951	1945	1945
Normal rating per cct.-Mva	100	110	90	140 (2 cct)	140	140	34	34	91	75	75
STRUCTURES											
(S)teel, (W)ood, (A)lum	S	W	W	S	S	S	S	S	W	S	W
Av. No. per mile	6	6	5	5.85	5.77	5.3	8	7	8	6.3	16.6
Types (S)q, (A)-or (H)-frame*	(S-14)	H (W-5)	H (W-14)	S (S-12)	S (S-12)	S (S-12)	S (S-9)	S (S-9)	H (W-14)	S (S-9)	H (W-3)
Min. flashover-60 cps kv	800	500	500	415 (wet)	415 (wet)	415 (wet)	415	415	605	375 (wet)	335 (wet)
No. of circuits (D)nst. (P)rov	1	1	1	2	(I)-1 (P)-2	(I)-1 (P)-2	2	2	1	2	1
Crossarms, (W)ood, (S)teel, (A)lum	S	W	W	S	S	S	S	S	W	S	W
Bracing (S)teel, (W)ood	S	W	W	S	S	S	S	S	W	S	W (Some)
Av. weight per struc.-lb	22,000	11,000	10,000	27,000	24,000	27,070	7,500	8,500	Not Known	20,406	.....
Insul. in guys (W)ood, (P)orc.-kv	None	None	None	.....	.....	.....	No guys	No guys	W 132	None	Res. Impr.
CONDUCTORS											
C; A, S, ACSR, Cw, (H)ollow	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	C	C
Diam, cir mil or gage	336,400	636,000	336,400	477,000	477,000	477,000	336,400	336,400	954,000	300,000	300,000
Stranding	30/7	26/7	30/7	26/7 & 30/7 (3°C)	26/7	26/7 & 30/7 (4°C)	26/7	26/7	54/7	19	19
Weight per ft-lb	0.463	0.875	0.463	0.6557	0.6557	0.6557	0.463	0.463	1.229	0.9263	0.9263
Designed for ___ amp	530	760	530	620	620	620	150	150	400	600	600
Ph. config. (V)ert, (H)or, (T)riang	V	H	H	V	V	V	V	V	H	V	H
Cond. offset from vert.-ft	.....	.....	.....	6.5 (max)	6.5 (max)	6.5 (max)	2.5	2.5	.....	4	.....
Phase separation-ft	13	14.5	14.5	17.86 (Eq)	17.86 (Eq)	17.86 (Eq)	13	13	15.5	13	12
Span; normal-ft	868	951	1,010	960	960	960	660	720	660	880	335
Span, max.-ft	1,141	1,976	3,105	2,381.7(DE)	1,334.8 (Tang)	2,056.7 (DE)	900	1,016	700	962	443
Sag final-ft at deg F	14.1	16	19.4	27 (60 F_1 960 ft)	27 (60 F_1 960 ft)	27 (60 F, 960 ft)	12.5 (60 F)	11.9 (60 F)	16.5 (60 F)	31	7 (60 F)
Tension corresponding	3,300	6,050	3,200	2,803	2,803	2,803	1,840	2,120	4,050	2,930	1,867
Min. clear. to ground-ft	31	31	31	30	30	30	26	26	26	45	30
Min. clear. to struct-ft	7	4.5	4.5	5	5	5	6.5	6.5	5	4.4	6
Type armor at clamps	None	None	None	None	None	None	Rods	Rods	Rods	None	None
Type vibration dampers	Stockbridge	Stockbridge	Stockbridge	Stockbridge	Stockbridge	Stockbridge	None	Stockbridge	Stockbridge	None	None
Line altitude range-ft	800	750 to 1,000	750 to 1,250	475 to 907	490 to 920	480 to 890	660 to 690	600 to 795	600 to 810	585	585
Max. corona loss-kw/3-ph. mile	None	None	None	Calc. to be 0	Calc. to be 0	Calc. to be 0	0.5	0.5	0.4	.....	.....
INSULATION											
Basic imp. insul. level-kv	760	760	760	930	930	930	1,320	1,320	1,650	860	1,120
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	8 x 80	8 x 80	8 x 80	10	10	10	10 x 415	10 x 415	8 x 335	9	8
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	10 x 80	10 x 80	10 x 80	10	10	10	11 x 455	11 x 455	10 x 415	9	8
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D (Dbl Str)	D (Dbl Str)	D (Dbl Str)	D	D	D	D	D
No. units and kv rating (or in.)	10 x 80	10 x 80	10 x 80	12	12	12	11 x 455	11 x 455	11 x 455	9	9
Impulse reduction-kv or %	.....	.....	.....	None	None	None	.....	.....	.....	.....	.....
BIL of term. apparatus-kv	230	230	230	650	650	650	650	650	650	115	115
IMPULSE SURGE PROTECTION											
No. of ground wires	1	2	2	1 (per cir)	1 (per cir)	1 (per cir)	2	2	2	2	2
Grd. wire matl. and size	7/16 Cw	3 No. 5 Cw	3 No. 5 Cw	159,000 ACSR	159,000 ACSR	159,000 ACSR	110,800 ACSR	110,800 ACSR	⅜ HS St	7/16 HS St	3 No. 8 Cw
Angle of prot-deg	30	30	30	9 & 15	9 & 15	9 & 15	V-config.	V-config.	30	.....	37
Grd. wire clear., mid-span-ft	47	46	49	25	25	25	13.3	13.3	20	31	13
Grd. res. range-ohms	5 to 20	10 to 200	50 to 300	0 to 6	0 to 6	0 to 6	2 to 20	2.5 to 8	4 to 50	1 to 4	12 (max)
Counterpoise (L)inear, (C)rowfoot	None	None	None	None	None	None	None	None	None	None	None
Neut. gdg. (S)olid, (R), (X), (T)ransf	S	S	S	S	S	S	S	S	S	S	S
Neut. gdg.-equiv. ohms	.....	.....	.....	0	0	0	.....	.....	.....	1	1
Arrester rating-kv	109	109	109	138	138	138	145	145	145	121	121
Expulsion tube gap-in	.....	.....	.....	None	None	None	None	None	None	None	None
Arcing horn gap-in	.....	.....	.....	None	None	None	None	None	None	53	53
Arcing ring top diam-in	.....	.....	.....	None	None	None	18	None	None	None	None
Arcing ring bot. diam-in	.....	.....	.....	None	None	None	18	None	None	None	None
Type relaying	Dir. Z Carr.	Dir. Z Carr.	Dir. Z Carr.	Carr. Pilot Ph. Comp.	Carr. Pilot Ph. Comp.	Carr. Pilot Mho Sens.	Carr.	Carr.	Carr.	OC	OC
Breaker interruption-cycles	4	4	4	5 to 8	5 to 8	5 to 8	8	5	5	16	8
Reclosure delay-cycles	17	17	17	Inst.	Inst.	Inst.	No Recl.	No Recl.	No Recl.	Manual	Manual
VOLTAGE REGULATION											
Nominal-%	10	10	10	5	7	7	3	3	3	.....	.....
Synch. cond.-kva	.....	.....	.....	None	None	None	None	None	None	None	None
Synch. cond. spacing-miles	.....	.....	.....	None	None	None	.....	.....	.....	None	None
Shunt cap.-kva	.....	.....	.....	None	None	None	None	None	None	None	None
Shunt cap. spacing-miles	.....	.....	.....	None	None	None	.....	.....	.....	None	None
Series capacitor-kva	.....	.....	.....	None	None	None	None	None	None	None	None
COMMUNICATION											
Telep circ on struct	.....	.....	.....	None	None	None	None	None	None	None	None
Carrier frequency-kc	65.5	65.5	65.5	57 & 95	None	None	92	80	180	None	None
Pilot wire	.....	.....	.....	None	None	None	None	None	None	None	None
Microwave-Mc	.....	.....	.....	None	None	None	None	None	None	None	None

* Parentheses refer to configuration diagrams on page 150

EAST NORTH CENTRAL

No. Indiana Public Service Co							Pub. Service of No. Illinois		Cent. Illinois Pub. Service		Consumers Power Co	
13,803	13,807	13,810	13,814	13,815	13,816	13,821	1,902	1,808	.....	.....	Hemphill-Delhi	Mio-Higgins
138	138	138	138	138	138	138	138	138	138	138	138	138
60	60	60	60	60	60	60	60	60	60	60	60	60
4.56	22.84	23.00	3.17	17.64	6.83	6.83	24.3	23.6	109	37	51.8	30.2
Marktown	Monticello	Michigan City	Sagunay Jct.	Michigan City	Maple	Maple	Joliet Sta.	Will Co. Sta.	Pana	Grand Tower	Flint	Mio Dam
Roxana	Lafayette	Aetna	St. Joseph Co. line	Flint Lake	Tower 1033	Tower 1033	Bradley SS	Bedford Pk SS	W. Frankfort	W. Frankfort	Lansing	Higgins SS
1951	1946	1952	1952	1952	1952	1952	1949	1953	1947	1950	1941	1951
96	96	96	96	18.75	96	96	78	163	50	100	125	110
S	W	S	W	S	S	S	W	S	W	W	W	W
7.2	10	5.5	11	5.8	5.7	5.7	9.2	8.5	9.5	7.5	8	11
S (S-9)	H (W-15)	S	H (W-3)	S (S-13)	S (S-14)	S (S-14)	H (W-11)	S (S-4)	H (W-4)	H (W-4)	H (W-10)	1 (W-23)
375 (wet)	335 (wet)	375 (wet)	335 (wet)	375 (wet)	375 (wet)	375 (wet)	485	540	375 (wet)	375 (wet)	335 (wet)	270 (wet)
2	1	2	1	2	2	2	1	1 (I), 2 (P)	1	1	1	1
S	W	S	W	S	S	S	W	S	W (spar)	W (spar)	W	W
S	W (some)	S	W (some)	S	S	S	W	S	W	W	W	W
20,406	.....	13,030	.....	16,485	13,030	13,030	.....	.....	6,000	6,000	6,000	2,500
None	Res. Impr.	None	Pregwood	None	None	None	W	None	W	W	W	W
C	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	C	ACSR	ACSR	ACSR
300,000	4/0	397,500	397,500	397,500	397,500	397,500	477,000	900,000	350,000	556,500	336,400	266,800
19	6/1	30/7	30/7	30/7	30/7	30/7	26/7	54/7	19	26/7	26/7	26/7
0.9263	0.2921	0.6216	0.6216	0.6216	0.6216	0.6216	0.656	1.158	1.081	0.765	0.4624	0.3656
600	360	510	540	540	540	540	341	714	670	730	600	500
V	H	V	H	V	V	V	H	V	H	H	H	T
4	.....	3	.....	3½	3	3	.....	0	.....	.....	.....	.....
13	14	13	12	13	13	13	17 (gallop.)	20 (gallop.)	14.5	14.5	15.4	10, 15.5, 13.3
880	425 & 600	1,000	450	1,000	1,000	1,000	525	620	550	700	660	500
965	1,215	1,081	1,273	1,105	1,055	1,055	600	750	650	1,200	1,000	550
31	5½ & 9½	25.3	6½	25.3	25.3	25.3	13.9	15.5	10.25 (550 ft)	13.1 (700 ft)	14.0	7.5
2,930	1,220	3,060	2,400	3,060	3,060	3,060	2,120	5,275	3,900	3,600	1,790	1,735
48	26	29½	25	29½	29¾	29¾	30	29	26.2	26.7	28.0	27.5
4.4	7	4.4	6	4.4	4.4	4.5	4.5	4.5	4½	4½	5	4.7
None	Tapered	Tapered	Tapered	Tapered	Tapered	Tapered	Tapered	Tapered	None	Tapered	Tapered	Tapered
None	Alcoa	Alcoa	Alcoa	Alcoa	Alcoa	Alcoa	Stockbridge (DE)	Stockbridge (DE)	None	Stockbridge (DE)	Stockbridge	Stockbridge
585	650	600	600	600	600	600	645 to 760	580 to 730	450 to 600	380 to 600	700 to 950	1,000 to 1,300
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Negligible	Negligible
860	1,300	860	1,120	860	860	860	1,400 (dry)	845	1,850 (1,120 crit.)	1,800 (1,120 crit.)	1,450 (950 crit.)	1,400 (900 crit.)
D	D	D	D	D	D	D	D	D	D	D	D	D
9	8	9	8	9	9	9	8	9	9 x 5¾	9 x 5¾	8	7
D	D	D	D	D	D	D	D	D	D	D	D	D
9	8	9	8	9	9	9	8	9	12 x 5¾	17 x 5¾	8	7
D	D	D	D	D	D	D	.....	.....	D	D	D	D
9	9	9	9	9	9	9	4	4	12 x 5¾	17 x 5¾	8	8
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	None	None
115	115	115	115	115	115	115	650 (FWFO)	650 (FWFO)	650	1,050	650	650
1	2	1	2	1	2	2	2 (Stkbrdge damp)	1 (Stkbrdge damp)	2	2	2	1
134,600 ACSR	3 No. 8-5/16 Cw	⅜ HS St	⅜ HS St	159,000 ACSR	⅜ HS St	⅜ HS St	134,000 ACSR	134,600 ACSR	⅜ EHS Cw	⅜ EHS St	⅜ St	5/16 St
.....	36	26½	37	17½	26½	26½	32	30	34	34	35	37
18½	10	20	10.75	0.5 to 5.0	22	22	22.8	30	18 (550 ft)	20 (700 ft)	14.0	12.4
1.5 to 4	10 (max)	1.3 to 5.5	12 (max)	None	1.6 to 4.8	1.6 to 4.8	2 to 5	2 to 10	15	15	2 to 15	2 to 100
None	None	None	None	None	None	None	None	None	None	None	L	None
S	S	S	S	S	S	S	S	S	S	S	S	Isolated
1	1	1	1	1	1	1	.....	.....	0	0	1 (max)	.....
121	121	121	121	121	121	121	None	None	121	121	121	157 (2)
None	None	None	None	None	None	None	None	None	None	None	None	.....
53	None	53	None	53	53	53	None	None	None	None	.....	.....
None	None	None	None	None	None	None	None	None	None	None	.....	.....
None	None	None	None	None	None	None	None	None	None	None	.....	.....
OC	Carr. & Imp.	Carr. & Imp.	Carr.	Imp.	Carr. & Imp.	Carr. & Imp.	High Speed Carr.	High Speed Carr.	DZ	DZ	Step. Dist.	Step. Dist.
8	8	8	8	8	5	8	5	5	5	5	8	8
Manual	Manual	Manual	21	Manual	21	180	None	20	No Reel.	No Reel.	3	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	10
None	None	None	None	None	None	None	None	None	None	None	.....	.....
None	None	None	None	None	None	None	None	None	None	None	.....	.....
None	None	None	None	None	None	None	Only on system	Only on system	10,000 kva at	Frankfort SS	.....	.....
None	None	None	None	None	None	None	.....	.....	.....	.....	.....	.....
None	None	None	None	None	None	None	None	None	None	None	.....	.....
None	None	None	None	None	None	None	None	None	None	None	None	None
None	64	64	64	None	64	64	None	None	94.4–111	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	6,800	6,800	None	None

Characteristics of Typical Modern Transmission Lines in the

Region	EAST NORTH CENTRAL					WEST NORTH CENTRAL					
Company	Wisconsin Electric Power Co		Wisconsin Power & Light Co		Wis. Pub Serv Co	Union Electric Co of Missouri				Kansas Gas & Electric Co	
Line designation (Name or No.)	722	4522	.....	.....	K-37	Meramec-Rivermines1	Cahokia-Watson 2	Venice-Page 3	Cahokia-Venice 1,2	Omaha-Midian	Neosho-Marmaton
Voltage (nominal)-kv	132	132	138	138	138	138	138	138	138	154	138
Frequency — cps	60	60	60	60	60	60	60	60	60	60	60
Length-miles	24.1	27.6	106.03	11.2	48.1	44	14.7	8.34	4.35	268.5	38
Originates at	Port Wash.	St. Martins	N. Fond dulac	Janesville	Green Bay	Meramec Sta.	Cahokia	Venice Sta.	Cahokia Sta.	Midian SS	Neosho Sta.
Terminates at	Granville	W of Kenosha	Janesville	11.2 mi. E.	Oshkosh	Rivermines SS	Watson SS	Page SS	Venice Sta.	So. Omaha	Marmaton SS
Year of constr. (or recons)	1948	1948	1930	1938	1949	1952	1950	1950	1950	1942	1952
Rating per cct.-Mva	153	153	30 (max 70)	30 (max 70)	.....	143	125	125	125	40	60
STRUCTURES											
(S)teel, (W)ood, (A)lum.	S	W	S	.....	W	W	S	S	S	W	W
Av. No. per mile	8.3	9	7	10	9	8	7.5	9	6.5	9	8
Types (S)q, (A)-or (H)-frame*	(S-4)	(W-5)	H (S-11)	H (3 pole)	H (W-13)	H (W-5)	S (S-22)	S (S-22)	S (S-11)	H	H
Min. flashover-60 cps kv	445 (wet)	335 (wet)	590	485	.....	605 (wet)	640 (wet)	640 (wet)	640 (wet)	765	765
No. of circ. (I)nst. (P)rov.	1	1	1	1	1	1	1	1	2(1)	1	1
Crossarms, (W)ood, (S)teel, (A)lum.	S	W	S	W	W	W	W	W	W	W	W
Bracing (S)teel, (W)ood	S	W	S	W	W	W	.....	.....	None	W	W
Av. weight per struc.-lb	13,200	7,000	8,070	.....	5,200	7,500	12,000	10,000	10,000	6,000	8,500
Insul. in guys (W)ood, (P)orc.-kv	.....	W	None	Self Support	W	W	.....	.....	.....	W	W
CONDUCTORS											
C, A, S, ACSR, Cw, (H)ollow	ACSR	ACSR	C (Cal Br Core)	C (HT)	ACSR	ACSR	C	C	C	C (HT)	ACSR
Diam, cir mil or gage	477,000	477,000	250,000 equ	3/0 equ	266,800	795,000	350,000	350,000	350,000	683,250	336,400
Stranding	26/7	26/7	7C/3 Br.	12	26/7	26/7	12	12	12	12	26/7
Weight per ft-lb	0.656	0.656	0.871	0.525	0.367	1.098	1.081	1.081	1.081	0.7827	0.4624
Designed for ___ amp	670	670	475	405	460	720 (30F)	525 (30F)	525 (30F)	525 (30F)	580	530
Ph. config. (V)ert, (H)or, (T)riang.	V	H	V	H	H	H	V	V	V	H	H
Cond. offset from vert.-ft	6	.....	3	.....	.....	.....	.....	.....	3	.....	.....
Phase separation-ft	14.5	15.5	14.5, 13.5	15.5	14.5	16.5	15	15	12.83	14.5	14.5
Span, normal-ft	650	650	850	525	545	750	700	700	700	590	660
Span, max.-ft	700	650	1,300	600	700	1,180	975	1,100	1,204	1,200	880
Sag final-ft at deg F	14.2	12.6	17 (60F)	.....	13.8 (60F) 650)	24 (60F)	21 (60F)	21 (60F)	21 (60F)	13.83	10.33
Tension corresponding	2,850	2,850	4,200	.....	1,400	7,500 max	6,000 max	6,000 max	6,000	2,600	2,400
Min. clear. to ground-ft	29	25	28	28	28.5	26	30	30	30	25	27.5
Min. clear. to struct-ft	5	4.25	10	7	7	3.5	5.25	5.25	5.25	3	3
Type armor at clamps	Tapered	Tapered	None	None	.....	Preformed	None	None	None	None	Preformed
Type vibration dampers	Stockbridge	Stockbridge	Stockbrigde	None	Stockbridge	None	None	None	None	None	None
Line altitude range-ft	650	650	800 to 950	800≈	600	400 to 1,100	400 to 575	400 to 600	400 to 450	1,300	1,300
Max. corona loss-kw/3-ph. mile	0.1 (est)	0.1 (est)	0.8	1.0	.....	None	None	None	None	0.5	0.2
INSULATION											
Basic imp. insul. level-kv	850 to 1,025	1,500	930	760	.....	1,500	1,900	1,900	1,900	1,280	1,280
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	11 x 640	8 x 485	10 x 80	8 x 80	8 x 80/50	11	12	12	12	10	10
Angles, (D)isk, (P)in, (L)ine-post	D	D (Dbl str)	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	11 x 640	11 x 640	12 x 80	9 x 80	11 x 80/50	11	12	12	12	16	16
Term. (D)isk, (P)in, (L)ine-post	D (Dbl str)	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	12 x 690	8 x 485	12 x 80	9 x 80	11 x 80/50	13	14	14	14	16	16
Impulse reduction-kv or %	None	None	175	85	.....	None	None	None	None	.....	.....
BIL of term. apparatus-kv	650	650	550	550	.....	550	650	525	650	865	750
IMPULSE SURGE PROTECTION											
No. of ground wires	1	2	1(I), 1(P)	2	2	2	1	1	1	2	2
Grd. wire matl. and size	134,600 ACSR	134,600 ACSR	3/8 Cw, 3/8 HS St	1/4 Cw	3/8 H	7/16 SM St	7/16 HS Cw	7/16 HS Cw	7/16 Bronze	3/8 St	3/8 St
Angle of prot-deg	30	30	15	14	30	30	30	30	11	30	30
Grd. wire clear., mid-span-ft	23	18	.....	.....	13.5	18.5	23.5	23.5	20.7	20.6	16
Grd. res. range-ohms	10 (max)	10 (max)	4 to 50	4 to 50	10	15 max	20 max	20 max	20 max	2 to 25	2 to 25
Counterpoise (L)inear, (C)rowfoot	None	None	None	None	.....	None	None	None	None	None	None
Neut. gdg. (S)olid, (R), (X), (T)rans	Solid	Solid	Solid	Solid	T	S	S	S	S	S	S
Neut. gdg.— equiv. ohm	0	0	.....	.....	1	0	0	0	0	5	5
Arrester rating-kv	138	138	121	121	138	121	121	121	121	.....	121
Explusion tube gap-in	.....	.....	None	None	.....	None	None	None	None	.....	.....
Arcing horn gap-in	.....	.....	63	None	.....	None	None	None	None	26	.....
Arcing ring top diam-in	.....	.....	24	None	.....	None	None	None	None	.....	.....
Arcing ring bot. diam-in	.....	.....	24	None	.....	None	None	None	None	.....	.....
Type relaying	Carr. & OC	Carr. & OC	Dist. & OC Gnd.	Dist. & OC Gnd.	HZM, HRP, Carr.	Ph. ModDist Gnd. Reac. Dist	Pilot	Pilot	Pilot	Carr.	Carr.
Breaker interruption-cycles	5	5	5	5	8	3	3	3	3	5	5
Reclosure delay-cycles	Man. Rem.	Man. Rem.	.....	.....	6, 25. 45 sec.	None	None	None	None	20	20
VOLTAGE REGULATION											
Nominal-%	11	8	5	1	.....	±2.5	±2.5	±2.5	±2.5	5	5
Synch. cond.-kva	.....	.....	.....	.....	.....	50,000	None	None	None	None	None
Synch. cond. spacing-miles	.....	.....	.....	.....	.....	None	None	None	None	.....	.....
Shunt cap.-kva	.....	.....	.....	.....	4,815	None	None	None	None	None	None
Shunt cap. spacing-miles	.....	.....	.....	.....	.....	None	None	None	None	.....	.....
Series capacitor-kva	.....	.....	.....	.....	.....	None	None	None	None	None	None
COMMUNICATION											
Telep circ on struct	.....	.....	.....	.....	.....	None	None	None	None	.....	.....
Carrier frequency-kc	.....	.....	.....	.....	80.2	None	None	None	None	70	.....
Pilot wire	.....	.....	.....	.....	.....	None	Yes	Yes	Yes	.....	.....
Microwave-Mc	.....	.....	.....	.....	.....	1935-75, 957-9	None	None	None	.....	.....

* Parentheses refer to configuration diagrams. on page 150.

SOUTH ATLANTIC

Monongahela Power Co

.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
132 60 23.1 Rivesville Lake Lynn 41 75	132 60 15.0 Willow Isl. Trissler 47 75	132 60 39.3 Willow Isl. Natrium 47 75	132 60 17.5 Willow Isl. Marietta 47 75	132 60 11.9 Trissler Du Pont 47 75	132 60 2.7 Glen Falls 41 75	132 60 2.4 ..... Nat'l Carbon 41 75	132 60 18.8 Nat'l Carbon Buckhannon 48 75	132 60 56.4 Buckhannon Powell Mtn. 49 45	132 60 15.6 Buckhannon Norton 50 75	132 60 14.6 Wierton Jct. Wierton 49 75	132 60 38.8 Albright 52 100
S 4.9 S (S-16) 490 1 S S 10,500	W 8.5 H (W-5) 375 1 W W ..... W	W 6.9 H (W-5) 375 1 W W ..... W	W 6.6 H (W-5) 375 1 W W ..... W	W 6.7 H (W-5) 375 1 W W ..... W	S 5.2 S (S-11) 490 2 S S 16,000	W 8.3 A (W-5) 375 1 W W ..... W	W 6.1 H (W-5) 375 1 W W ..... W	W 7.1 H (W-5) 375 1 W W ..... W	W 7.0 H (W-5) 375 1 W W ..... W	W 7.0 H (W-5) 375 1 W W ..... W	W 6.8 H (W-5) 375 1 W W ..... W
Cw 4/0 EK 0.7484 370 H ..... 22 1,200 2,080 42.7 3,190 25 5.75 ..... 800 to 1,400 0.3	C 4/0 7 0.6533 360 H ..... 14.5 1,200 1,395 64.7 1,866 25 7.0 ..... 620 to 830 0.6	C 4/0 7 0.6533 360 H ..... 15.5 1,200 2,191 64.7 1,866 25 7.5 ..... 620 to 1,330 0.6	ACSR 336,400 26/7 0.4624 400 H ..... 14.5, 15.5 1,200 2,147 38 2,310 25 7.0 Tapered 600 to 1,000 0.1	ACSR 336,400 26/7 0.4624 400 H ..... 15.5 1,200 1,440 38 2,310 25 7.5 Tapered 650 to 850 0.1	Cw 4/0 EK 0.7484 370 V 2.5 14 1,000 2,200 28.5 3,300 25 5.75 ..... 950 to 1,500 0.6	C 4/0 7 0.6533 360 H ..... 14 1,000 880 44.1 1,887 25 6.5 ..... 950 to 1,500 0.6	ACSR 336,400 26/7 0.4624 400 H ..... 15.5 1,200 2,180 38 2,310 25 7.5 Tapered 1,100 to 1,800 0.1	ACSR 4/0 6/1 0.2921 255 H ..... 15.5 1,200 1,796 57 900 25 7.5 Tapered 800 to 2,300 0.3	ACSR 336,400 26/7 0.4624 400 H ..... 15.5 1,200 1,565 38 2,310 25 7.5 Tapered 1,450 to 2,450 0.1	ACSR 336,400 26/7 0.4624 400 H ..... 15.5 1,200 2,080 38 2,310 25 7.5 Tapered 700 to 1,300 0.1	ACSR 556,500 26/7 0.765 550 H ..... 15.5 1,200 2,320 36 3,800 25 7.5 Tapered 850 to 2,050 0.08
1,105 D 12 x 690 D 12 x 690 D 12 x 690 None 650 (CB) 750 (Ped)	1,400 D 9 x 540 D 9 x 540 D 9 x 540 None 650 (CB) 750 (Ped)	1,400 D 9 x 540 D 9 x 540 D 9 x 540 None 650 (CB) 750 (Ped)	1,400 D 9 x 540 D 9 x 540 D 9 x 540 None 650 (CB) 750 (Ped)	1,400 D 9 x 540 D 9 x 540 D 9 x 450 None 650 (CB) 750 (Ped)	1,105 D 12 x 690 D 12 x 690 D 12 x 690 None 650 (CB) 750 (Ped)	1,900 D 9 x 540 D 9 x 540 D 9 x 540 None 750	1,400 D 9 x 540 D 9 x 540 D 9 x 540 None 750	1,400 D 9 x 540 D 9 x 540 D 9 x 540 None 750	1,400 D 9 x 540 D 9 x 540 D 9 x 540 None 750	1,400 D 9 x 540 D 9 x 540 D 9 x 540 None 650, 750	1,400 D 9 x 540 D 9 x 540 D 9 x 540 None 650, 750
2 ⅜ Cw 8 27 2.5 to 49 C S ..... 109 (Tr) 121 (Bus) .... Def. Time Dir. OC 8–8 5	2 134,600 ACSR 26 27 ..... S ..... 109 (Tr) 121 (Bus) .... Dir. Dist. Carr. 5–5 30	2 3 No. 5 HS Cw 26 27 ..... S ..... 109(Tr) 121 (Bus) .... Dir. Dist. Carr. 5 30	2 134,600 ACSR 25 27 ..... S ..... 121 (Tr) 121(Bus) .... Dir. Dist. Carr. 5–5 30	2 134,600 ACSR 26 27 ..... S ..... 109 (Tr) 121 (Bus) .... Def. Time Dir. OC 5–5 30	2 ⅜ HS Cw 6 23 ..... C S ..... 109 (Tr) 109 (Bus) .... Def. Time Dir. OC 5 30	2 3 No. 5 HS Cw 26 23 ..... C S ..... 121 (Bus) .... Def. Time Dir. OC 5 30	2 134,600 ACSR 26 27 ..... S ..... 109 (Tr) 121 (Bus) .... Def. Time Dir. OC 5 30	2 101,800 ACSR 26 27 ..... S ..... 109 (Tr) .... Def. Time Dir. OC 5 30	2 3 No. 6 EHS Cw 26 27 ..... S ..... Oper. at 66 kv .... Def. Time Dir. OC 30	2 134,600 ACSR 26 27 ..... S ..... 121 (Bus) .... Pr. Dir. Carr. 5 30	2 ⅜ HS St 26 27 1.5 to 550 C S ..... 109 (Tr) 121 (Bus) .... Dir. Dist. Carr. 5 30
3 .... 136, 110	3 .... 95, 145	3 .... 105	3 .... 60, 130, 145	3	3	3	3	3	3	3 .... 51	3 .... 89 ....

Characteristics of Typical Modern Transmission Lines in the

Region	SOUTH ATLANTIC							EAST SOUTH CENTRAL			
Company	Monongahela Power Co			Potomac Edison Co			Virginia Electric Pwr Co	Kentucky Utilities Co		Louisville Gas & Electric Co	
Line designation (Name or No.)	.....	.....	.....	RC	AR	WC	Alderson-Hinton	Dix-Green R.	Ohio R.-Kenton	Ashbottom-Middlet'wn	Ft. Knox
Voltage (nominal)-kv	132	132	132	132	132	132	132	138	132	138	138
Frequency-cps	60	60	60	60	60	60	60	60	60	60	60
Length of line-miles	2.4	16.7	5.1	57.92	45.81	52	11.4	139	5	16	20
Originates at	.....	Albright	.....	Riverton	Albright	Marlowe	Alderson	Dix Dam Sta.	Ohio Power Co.	Ashbottom SS	Manslick SS
Terminates at	Glen Falls	.....	Lake Lynn	Ridgeley	Ridgeley	Ridgeley	Hinton	Green R. Sta.	Kenton Sta.	Middlet'wn SS	Tip Top SS
Year of constr. (recons)	1952	1952	1952	1949	1952	1953	1950	(5) 1948	(2) 1950	1952–1953	1951
Rating per cct.-Mva	100	100	100	50	100	100	.....	50	60	100	75
STRUCTURES											
(S)teel, (W)ood, (A)lum	S	W	S	W	W	W	S	S	W	S	W(4towers)
Av. No. per mile	4.5	7.4	.....	6.7	7.1	6.0	7	5.8	7	6	7
Types (S)q, (A)-or (H)-frame*	S (S-11)	H (W-5)	S (S-11)	H (W-14)	H (W-14)	H (W-14)	S	S (S-16)	H (W-14)	S	H
Min. flashover-60 cps kv	490	375	490	1,500	1,500	1,500	590 (dry), 415 (wet)	380	415	415	375
No. of circ. (I)nst. (P)rov	2	1	2	1	1	1	1(I), 2(P)	1	1	2	1
Crossarms, (W)ood, (S)teel, (A)lum	S	W	S	W	W	W	S	S	W	S	W
Bracing (S)teel, (W)ood	S	W	S	W	W	W	S	S	W	S	W
Av. weight per struc.-lb	16,000	.....	15,000	8,748	8,748	8,748	12,000	6,000	.....	18,800	8,000
Insul. in guys (W)ood, (P)orc,-kv	.....	W	.....	W (110)	W (110)	W (110)	.....	None	W	None	W (490)
CONDUCTORS											
C, A, S, ACSR, Cw, (H)ollow	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR
Diam. cir mil or gage	556,500	556,500	556,500	336,400	556,500	556,500	336,400	556,500	477,000	795,000	336,400
Stranding	26/7	26/7	26/7	26/7	26/7	26/7	26/7	26/7	26/7	26/7	26/7
Weight per ft-lb	0.765	0.765	0.765	0.462	0.766	0.766	0.46	0.766	0.670	1.09	0.463
Designed for amp	550	550	550	220	440	440	.....	210	250	780	325
Ph. config. (V)ert, (H)or, (T)riang	V	H	V	H	H	H	V	H	H	V	H
Cond. offset from vert.-ft	2.5	.....	2.5	.....	.....	.....	4	.....	.....	2.5	.....
Phase separation-ft	13	15.5	13	15.5	15.5	15.5	13	16.5	14.5	14.5	15.5
Span, normal-ft	1,200	1,200	1,200	786.6	742	882	.....	910	750	850	700
Span, max.-ft	2,200	2,010	1,300	2,663.5	2,418	3,260	1,700	2,000	1,600	1,270	3,300 Towers
Sag final-ft at deg F	40	36	40	28 (60F)	27 (60F)	27 (60F)	.....	114 (60F)	77 (60F)	.....	.....
Tension corresponding-lb	2,390	3,800	2,390	2,050	3,500	3,500	7,000	.....	.....	9,000	7,025 hvy ldg
Min. clear. to ground-ft	25	25	25	29	29	29	5	25	25	32	28 (60F)
Min. clear. to struct-ft	5.75	7.5	5.75	6	6	6	5	3.5	3.5	7	5 (30° swing)
Type armor at clamps	Preformed	Preformed	Preformed	Tapered	Preformed	Preformed	Tapered	Tapered	Tapered	.....	Preformed
Type vibration dampers	.....	.....	.....	None	None	None	Stockbridge	Stockbridge	Stockbridge	.....	D'd E'd only
Line altitude range-ft	850 to 2,050	850 to 2,450	850 to 2,450	400 to 2,340	600 to 2,920	360 to 2,135	800 to 2,500	400 to 1,200	550 to 1,000	485 to 830	460 to 800
Max. enrgna loss-kw/3-ph. mile	0.08	0.08	0.08	0.22	0.1	0.1	0.1	.....	.....	.....	.....
INSULATION											
Basic imp. insul. level-kv	1,105	1,400	1,105	.....	.....	.....	930 (crit FO)	930	930	650	1,400
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	12 x 690	9 x 540	12 x 690	10	9	9	10x80/50	10x15	10x15	10	9
Angles; (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	12 x 690	9 x 540	12 x 690	10	9	9	11x80/50	12x15	12x15	12	9
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	Pedestal	D	D	D	D
No. units and kv rating (or in.)	12 x 690	9 x 540	12 x 690	12	10	9	4	12x15	12x15	12	10
Impulse reduction-kv or %	None	None	None	.....	.....	.....	.....	.....	.....	.....	.....
BIL of term. apparatus-kv	650, 750	650, 750	650, 750	650	650	650	550 (Tr), 650	650	550	550	550
IMPULSE SURGE PROTECTION											
No. of ground wires	2	2	2	2	2	2	1	2	2	2	2
Grd. wire matl. and size	3 No. 6 EHS Cw	⅜ HS St.	½ HS St.	½	½	½	7/16 HS St.	7/16 Galv. St.	7/16 Galv. St.	⅜ Galv. St.	7/16 HS St.
Angle of prot.-deg	26	26	6	30	30	30	80	30	30	30	30
Grd. wire clear., mid-span-ft	23	27	27	7(1,200 ft)	7(1,200 ft)	7(1,200 ft)	20 to 30	21	21	20	14 (at H-frames)
Grd. res. range-ohms	.....	5 to 550	.....	8 to 500	12 to 500	.....	10 to 500	0.5 to 3.0	0.5 to 3.0	1 to 20	1 to 20
Counterpoise (L)inear, (C)rowfoot	C	C	.....	None	None	None	None	.....	.....	.....	.....
Neut. gdg. (S)olid, (R),(X), (T)ransf	S	S	S	.....	.....	.....	S	S	S	S	S
Neut. gdg.-equiv. ohms	.....	.....	.....	.....	.....	.....	.....	1 to 2.0	1 to 2.0	10	10
Arrester rating-kv	109 (Tr) 109 (Bus)	109 (Tr) 121 (Bus)	121 (Bus)	.....	.....	.....	None	115	109	121	121
Expulsion tube gap-in	.....	.....	.....	.....	.....	.....	None	.....	.....	.....	.....
Arcing horn gap-in	.....	.....	.....	.....	.....	.....	None	.....	.....	38.25	38.25
Arcing ring top diam-in	.....	.....	.....	.....	.....	.....	None	.....	.....	.....	.....
Arcing ring bot. diam-in	.....	.....	.....	.....	.....	.....	None	.....	.....	.....	.....
Type relaying	Dir. Dist. Carr.	Dir. Dist. Carr.	Dir. Dist. Carr.	Carr.	Carr.	Carr.	Dist. Carr.	GCX Dist. (no Carr.)	GCX (with Carr.)	Pilot Wire & Dir. OC	Dir. Z
Breaker interruption-cycles	8	5	.....	5	5	5	5	8	5	8	8
Reclosure delay-cycles	30	30	30	20	20	20	20	20	17	35	35
VOLTAGE REGULATION											
Nominal-%	3	3	3	2	5	5	.....	5	5	10	10
Synch. cond.-kva	.....	.....	.....	.....	.....	.....	10,000	.....	.....	.....	.....
Synch. cond. spacing-mile	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shunt cap.-kva	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shunt cap. spacing-miles	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Series capacitor-kva	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
COMMUNICATION											
Telep circ on struct	.....	.....	.....	.....	.....	.....	None	.....	.....	.....	.....
Carrier frequency-kc	89	70, 110	70, 110	.....	143	.....	Relaying only	195, 50, 99 150, 188, 186	101.5, 200	.....	.....
Pilot wire	.....	.....	.....	.....	.....	.....	None	.....	.....	.....	.....
Microwave-Mc	.....	.....	.....	.....	.....	.....	None	.....	.....	.....	.....

* Parentheses refer to configuration diagrams. on page 150.

WEST SOUTH CENTRAL

Southwestern Gas & Electric Co		Oklahoma Gas & Electric Co		Public Service Co of Oklahoma		Central Power & Light Co	Texas Power & Light Co	Gulf States Utilities Co		
182/256	181/241	Osage-Enid	Horseshoe Lake -Reno St.	81-801	81-802	Victoria-Bexar	Lake Creek-Temple	86 & 96	17	254/257/303
138	138	138	138 (Now oper. at 66)	138	138	138	138	138	138	138
60	60	60	60	60	60	60	60	60	60	60
164.05	124.5	49	5.28	103.7	61.4	107.7	32.9	79.39	51.37	133.20
Ashdown; Ark.	Ashdown; Ark.	Osage Sta.	H. L. Sta.	Chickasha	Weleetka	Victoria	Lake Creek Sta.	Dayton	Neches	Riverside
Veleetka, Okla.	Overton, Tex.	Enid SS	Reno St. SS	Weleetka	Tulsa	Atascosa-Bexar County Line	Temple SS	Navasota	Riverside	Baton Rouge
1941	1942	1946	1947	1941	1950	1951	1952	1950	1951	1949
35	50	25/47.5	50	60	60	.....	100	50/50	60	50/60/60
W	W	W	S	W	W	W	W	W	W	W
8.4	8.8	8.0	6.8	8	8.8	9	10	9	9	8/9/9
H (W-6)	H (W-6)	H (W-4)	S (S-7)	H (W-6)	H (W-14)	H (W-12, inside K)	H (W-11)	H (W-10)	H (W-8)	H (W-10)
385	375	510	590	375	375	415	375 (wet)	540	540	.....
1	1	1	1(D), 2(P)	1	1	1	1	1	1	1/1/1
W	W	W	S	W	W	W	W	W	W	W
W	W	W	S	W	W	W	W	W	W	W
5,225	5,225	7,350	10,750	6,000	5,500	.....	7,850	6,020	6,345	7,345
W	W	None	None	W (138)	W (138)	W	None	W (2 x 9 ft)	W (2 x 9 ft)	W (2 x 9 ft)
Cw/C	C	ACSR	ACSR	Cw	ACSR	ACSR	ACSR	ACSR	C	C
3/0	4/0	336,400	477,000	3/0	266,800	266,800	636,000	336,400	4/0	4/0
12 x 0.1697 Cw	12	30/7	26/7	Type S	26/7	26/7	26/7	26/7	7	7
12 x 0.1120 C										
0.632	0.653	0.5271	0.6566	0.632	0.367	0.367	0.875	0.463	0.6533	0.6533
400	450	105	210	420	460	470	600	400	400	400
H	H	H	V	H	H	H	H	H	H	H
None	None	.....	4	.....	.....	.....	.....	.....	.....	.....
14	14	15.5	13.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
630	600	750	900	660	600	600	520	600	600	600
1,810	1,525	850	975	2,084	1,940	800	600	700	700	700
10	14	11.8 (60F)	18.5 (60F)	14 (60F; 750 ft)	15 (60F, 650 ft)	7.7 (60F)	8.75 (60F; 520 ft)	7.75 (60F)	9.7 (60F)	9.7 (60F)
3,050	2,076	3,180	3,630	3,140	1,280	2,136	3,400	2,685	3,050	3,050
24	24	27	27	23	23	24	28	27	23	27
6.5	6.5	7.75	7.75	3.33	3.33	4.5	5	5	5	5
None	None	Rods	Rods	Tapered	Tapered	Tapered	Tapered	Preformed or Tapered	None	None
None	None	Stockbridge	Stockbridge	Stockbridge	Stockbridge	None	Stockbridge	None	None	None
300 to 1,300	270 to 525	1,000 to 1,250	1,100 to 1,200	650 to 1,200	650 to 1,000	90 to 500	450	20 to 50	10 to 30	10 to 30
0.34	0.32	0.1	0.08	0.32 (Calc.)	0.62 (Calc.)	5.6	0.09	0.2	0.8	0.8
895 to 1,140	860 to 1,105	650	650	840	840	1,450	1,265	1,300 (Tang.)	1,300 (Tang.)	1,300 (Tang.)
D	D	D	D	D	D	D	D	D	D	D
9	8	9	10	9 x 5.75	9 x 5.75	10 x 945	9 x 1,265	9 x 540 (dry)	9 x 540 (dry)	8/9/9x485/540 (dry)
D	D	D	D	D	D	D	D	D	D	D
10	10	12	12	9 x 5.75	9 x 5.75	10 x 945	14 x 1,265	10 x 590 (dry)	10 x 590 (dry)	10 x 590 (dry)
D	D	D	D	D	D	D	D	D	.....	.....
12	12	12	12	12 x 5.75	12 x 5.75	12 x 1,105	14 x 1,265	12 x 690 (dry)	12 x 690 (dry)	12 x 690 (dry)
.....	.....	.....	.....	.....	.....	.....	None	450 dry	450 dry	450 dry
650	650	650	550	650	650	550(Tr), 650 (OCB)	.....	161	161	161
2	2	2	2	2	2	2	2	1	1	1
3/8 HS St.	3/8 HS St.	1/4 EHS St.	1/4 EHS St.	3/8 Galv. St.	3/8 Galv. St.	80,000 ACSR	3/8 EHS St.	1/4 EHS St. Cw	7/16 St. & EHS Cw	3 No. 7 EHS Cw
30	30	30	30	30	30	30	27	32	54	32
15	20	16.4 (60F, Fin. Sag)	19.7 (60F, Fin. Sag)	15	15	16	17	16.2	12	15.85
10 to 1,000	5 to 100	5 to 100	1 to 25	3 to 50	4 to 40	1 to 20	1 to 30	5 (max)	5 (max)	5 (max)
None	None	None	None	None	None	None	None	None	None	None
S	S	S	S	S	S	S	S	S	S	S
.....	.....	0+	0+	0	0	.....	.....	1 (max)	1 (max)	1 (max)
121	121	121	Oper at 66	121	121	121	121	121	121	121
None	None	None	None	.....	.....	917 kv	None	None	None	None
None	None	None	None	.....	.....	42 (Sta. D.E. only)	12 & 8 (Ser. at term.)	None	None	None
None	None	None	None	.....	.....	.....	30	None	None	None
None	None	None	None	.....	.....	.....	30	None	None	None
Z & Carr.	Z & Carr.	Dir. Dist.	Dir. Dist.	HS Carr.	HS Carr.	HZM Carr.	HZM Carr.	Dist.	Ph. Comp. Carr.	Ph. Comp. Carr.
5	5	8	8	8	5	5	3 to 5	8	8	8
2	2	Sup. Contr.	300	Inst.	Inst.	20	20	Inst.	Manual	Manual
2.5	2	5	0.8 (5.28 mi.)	10	10	5	.....	2.73	1.2	3
None	None	None	None	.....	.....	None	.....	7,500	None	7,500
None	None	None	None	.....	.....	.....	.....	Mid-point	.....	Mid-point
None	None	None	None	5,000 & 10,000 Sw.	10,000 Sw.	None	.....	None	None	3,240
None	None	None	None	.....	.....	.....	.....	.....	.....	Mid-point
None	None	None	None	.....	.....	None	.....	None	None	None
None	None	None	None	.....	.....	.....	None	None	None	None
135	121, 50, 117, 144	115	50, 75 (Comm) 140 (Tel & Ret)	88	88	65, 115	63	85	51 to 68	51 to 68
None	None	None	None	.....	.....	.....	None	None	None	None
None	None	None	None	.....	.....	.....	None	None	None	None

Characteristics of Typical Modern Transmission Lines in the

Region	WEST SOUTH CENTRAL									
Company	Houston Lighting & Power Co							Lower Colorado River Authority		
Line designation (Name or No.)	26	25	5	10	8	9	21	16/16A/16B	8	17A/17B
Voltage (nominal)-kv	132	132	132	132	132	132	132	138	138	138
Frequency-cps	60	60	60	60	60	60	60	60	60	60
Length-miles	51.4	49.7	38.3	7.1	14.7	13.1	12.4	41.4	41.4	41.4
Originates at	West Jct	West Jct	West Jct	Greens Bayou	Greens Bayou	White Oak	Deep Water	Hi-Cross	Marble Falls	Elgin
Terminates at	Dow Chem.	Peters	La Marque	Deepwater	Crosby	Satsuma	Alexander Isle	Comal	Granite Shoals	Winchester
Year of constr. (or recons.)	1941	1942	1952	1952	1952	1951	1951	1952	1950	1952
Rating per cct.-Mva	100	100	100	200	100	100	200	60	60	60
STRUCTURES										
(S)teel, (W)ood, (A)lum.	W	W	W	S	W	W	W	W	W	W
Av No. per mile	8	9.5	10	11	10	10	11	8	8	8
Types (S)q, (A)- or (H)-frame*	H (W-14)	H (W-14)	H (W-5)	S (S-4)	H (W-5)	H (W-5)	H (W-5)	H (W-10)	H (W-14)	H (W-17)
Min. flashover-60 cps kv	360	375	375	415	375	375	375	450	450	450
No. of circ. (D)nst. (P)rov.	1	1	1	1(I), 2(P)	1	1	1	1	1	1
Crossarms, (W)ood, (S)teel, (A)lum.	W	W	W	S	W	W	W	W	W	W
Bracing (S)teel, (W)ood	W	W	W	S	W	W	W	W	W	W
Aver. weight per struc.-lb	7,000	7,000	7,000	14,000	7,000	7,000	7,000	.....	.....	.....
Insul. in guys (W)ood, (P)orc.-Kv	None	None	None	.....	None	None	None	None	None	None
CONDUCTORS										
C, A, S, ACSR, Cw, (H)ollow	ACSR	C	ACSR	A	ACSR	ACSR	A	ACSR	ACSR	ACSR Cw/C
Diam, Cir mil or Gage	397,500	4/0	397,500	800,000	397,500	397,500	800,000	336,400	336,400	336,400 & 4/0
Stranding	26/7	12	26/7	37	26/7	26/7	37	26/7	26/7	26/7 & 5/2
Weight per ft-lb	0.546	0.653	0.546	0.751	0.546	0.546	0.751	0.4624	0.4624	0.462 & 0.789
Designed for —— amp	500	400	500	800	500	500	800	530	530	530
Ph. config. (V)ert, (H)or. (T)riang.	H	H	H	V	H	H	H	H	H	H
Cond. offset from Vert.-ft	.....	.....	.....	0	.....	.....	.....	.....	.....	.....
Phase separation-ft	14.5	14.5	14.5	12	14.5	14.5	14.5	14.6	14.6	14.6
Span, normal-ft	650	565	525	480	525	525	480	700	700	700
Span, max.-ft	710	600	600	525	600	600	525	900	1,650	1,000
Sag final-ft at deg F	10.5	13	7.25	10.75	7.25	7.25	10.75	19.5 (60 F)	19.5 (120 F)	19.5 (120 F)
Tension corresponding	2,800	2,050	2,575	2,800	2,575	2,575	2,800	2,090	2,090	2,090
Min. clear. to ground-ft	30	30	30	35	30	30	30	25	25	25
Min. clear. to struct-ft	3	3	3	3	3	3	3	2.75	2.75	2.75
Type armor at clamps	Tapered	None	Tapered	Tapered	Tapered	Tapered	Tapered	Tapered	Tapered	Tapered
Type vibration dampers	None	None	None	None	None	None	None	None	None	None
Line altitude range-ft	30 to 80	80 to 100	35 to 80	70 to 80	70 to 90	80 to 90	40 to 80	500	500	500
Max. corona loss-kw 3-ph. mi	0.2	0.6	0.2	Negligible	0.2	0.2	Negligible	Negligible	Negligible	Negligible
INSULATION										
Basic imp. insul. level-kv	1,250	1,200	1,200	950	1,200	1,200	1,200	720	720	720
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D
No. units and Kv rating (or in.)	8 (15, Fog)	9 (15)	9 (15)	10 (15)	9 (15)	9 (15)	9 (15)	9 (15)	9 (15)	9 (15)
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	14 (15)	14 (15)	14 (15)	12 (15)	14 (15)	14 (15)	14 (15)	11 (25)	11 (25)	11 (25)
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D
No. units and Kv rating (or in.)	14 (15)	14 (15)	14 (15)	12 (15)	14 (15)	14 (15)	14 (15)	11 (25)	11 (25)	11 (25)
Impulse reduction-kv or %	.....	.....	.....	.....	.....	.....	.....	None	None	None
BIL of term. apparatus-kv	650	650	650	350	350	350	350	.....	.....	.....
IMPULSE SURGE PROTECTION										
No. of ground wires	2	2	2	1	2	2	2	2	2	2
Grd. wire matl. and size	3/8 in. S	3/8 in. S	3/8 in. S	3/8 in. S	3/8 in. S	3/8 in. S	3/8 in. S	3/8 in. HSG	3/8 in. HSG	3/8 in. HSG
Angle of prot-deg	31	31	31	30	31	31	31	30	30	30
Grd. wire clear., mid-span-ft	16	19.5	15	26	15	15	18.5	25	25	25
Grd. res. range-ohms	0.5 to 5	0.5 to 5	0.5 to 5	0.5 to 5	0.5 to 5	0.5 to 5	0.5 to 5	0 to 1,000	0 to 1,000	0 to 1,000
Counterpoise (L)inear, (C)rowfoot	None	None	None	None	None	None	None	None	None	None
Neut. gdg. (S)olid, (R), (X), (T)ransf	S	S	S	S	S	S	S	S	S	S
Neut. gdg. (equiv. ohms)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	None	None	None
Arrester rating-kv	None	None	None	60	60	None	60	138	138	138
Expulsion tube gap-in	None	None	None	None	None	None	None	None	None	None
Arcing horn gap-in	19	23	23	14	14	10	12	None	None	None
Arcing ring top diam-in	None	None	None	None	None	None	None	None	None	None
Arcing ring bot. diam-in	None	None	None	None	None	None	None	None	None	None
Type relaying	Carr. Dist.	Carr. Dist.	Carr. Dist.	Carr. Dist.	Carr. Dist.	Carr. Dist.	Carr. Dist.	Z	Z	Z
Breaker interruption-cycles	5	5	5	8	8	8	8	.....	.....	.....
Reclosure delay-cycles	900	900	900	900	900	900	900	Inst.	Inst.	Inst.
VOLTAGE REGULATION										
Nominal-%	±3	±3	±3	±3	±3	±3	±3	3	3	3
Synch. cond.-kva	None	None	None	None	None	None	None	None	None	None
Synch. cond. spacing-miles	.....	.....	.....	.....	.....	.....	.....	None	None	None
Shunt cap.-kva	None	None	None	None	None	None	None	None	None	None
Shunt cap. spacing-miles	.....	.....	.....	.....	.....	.....	.....	None	None	None
Series capacitor-kva	None	None	None	None	None	None	None	None	None	None
COMMUNICATION										
Telep circ on struct	Carrier	None	None	None	None	None	None	None	None	None
Carrier frequency-kc	89	None	None	None	None	None	None	115	115	115
Pilot wire	None	None	None	None	None	None	None	None	None	None
Microwave-Mc	None	None	None	None	None	None	None	None	None	None

* Parentheses refer to configuration diagrams on page 150.

			MOUNTAIN						PACIFIC		WEST NO. CENTRAL	
City P. S. Bd. San Antonio			Idaho Power Co		Utah Power & Light Co				Dept of Water & Power Los Angeles		Iowa Illinois Gas & Elec Co	
West Side-Callaghan Rd 138 60 3.45 West Side Callaghan Rd 1949–1952 70	Callaghan Rd Leon Creek 138 60 8.13 Callaghan Rd Leon Creek 1949–1952 70	Leon Creek Grandview 138 60 22.7 Leon Creek Grandview 1949–1952 70	Am. Falls-Don 138 60 19.6 American Falls Don SS 1952 160	Strike-Caldwell 138 60 73.3 Strike Hyd. Sta. Caldwell SS 1953 120	Goshen-RTS 132 60 45.17 Goshen SS React. Test Sta. 1950 20	Soda-Monsanto 132 60 6.60 Soda Plant Monsanto Chem. 1951 35	Oneida-Montp'l'r 132 60 22.91 Oneida Sta. Montp'l'r SS 1950 12	Roy-Riv'dale-2 132 60 3.58 Roy SS Riverdale Sta. 1952 50	Wilm'ton-Gramercy 138 60 11.2 Wilmington SS Gramercy SS 1942–49 180	Valley-Toluca 138 60 7.1 Valley Sta. Toluca Rec. Sta. Und. Const. 265	Davenport-Hills 161 60 59.4 Davenport Hills, Iowa 1946 50 (2L-G)	Hills-Searsboro 161 60 60.5 Hills, Iowa Des Moines Iowa 1947 50 (2L-G)
W (2 tower) 17 S 485 (dry); 340 (wet) 1 W, (S on towers) W Est. 4,000 W	W (3 tower) 9 H (W-19) 485 (dry), 340 (wet) 1 W, (S on towers) W Est. 5,500 None	W (4 tower) 9 H (W-5) 485 (dry), 340 (wet) 1 W, (S on towers) W Est. 5,500 None	S 4.4 S (S-4, no. gd W) 600 (I)-1, (P)-2 S S 17,600 None	S & W 4.4 & 8.25 S & H (W-14) 600–500 1 S & W S & W 21,700 W-110	W 7.05 H (W-12) 350 1 W 3,300	W 7.88 H (W-12) 350 1 W 3,300	W 8.21 H (W-12) 350 1 W 3,300	W 8.10 H (W-12) 350 1 W 3,300	S 7.7 S (S-8) 425 2 S S 13,500 None	S 7.0 S (S-8) 425 2 S S 12,170 None	W 8 H 490 (wet) 1 W W 6,000 W-325	W 8 H 490 (wet) 1 W W 6,000 W-325
ACSR 266,800 26/7 0.367 389 H ..... 10.3 300 350 2.75 1,950 28 .... None Avg. 643 Not available	ACSR 266,800 26/7 0.367 389 H (W-19) ..... 14 600 700 7 2,153 28 .... None Avg. 643 Not available	ACSR 266,800 26/7 0.367 389 H (W-5) ..... 14 600 700 7 2,153 28 .... None Avg. 593 Not available	ACSR 715,500 26/7 0.984 700 V 4 13.5 1,100 1,450 33 (120F) 5,400 26 5 Tapered Rods None 4,500 to 5,000 0.1	ACSR 715,500 26/7 0.984 700 V & H ..... 13.5 1,100 & 660 1,573 & 1,050 33 & 12.2 (120 F) 5,400–4,400 26 5 Tapered Rods None 2,000 to 2,500 0.1	ACSR 397,500 26/7 0.5464 200 H ..... 13.5 800 1,145 11.75 (60 F) 3,700 25 6 PF ..... to 5,260 0.21	ACSR 397,500 26/7 0.5464 200 H ..... 13.5 700 1,050 11.00 (60 F) 3,050 25 6 PF ..... to 6,070 0.23	ACSR 336,400 26/7 0.4624 160 H ..... 13.5 800 1,300 13.75 (60 F) 2,700 25 6 PF ..... to 8,240 0.52	ACSR 4/0 6/1 0.2921 125 H ..... 13.5 800 1,351 13.75 (60 F) 1,700 25 6 PF ..... to 4,540 0.75	Copper 500,000 37 1.544 775 V None 15.0 750 1,068 20 (60 F) 5,370 40 5.5 None None 0 to 200 Negl.	ACSR 1,113,000 54/19 1.429 1,110 V None 14.75 800 1,050 16 (60 F) 7,200 40 5.5 Preformed Stockbridge 600 to 900 Negl.	ACSR 397,500 26/7 0.5464 600 H None 15.5 750 1,500 11 (60 F) 3,500 32 4.83 Tapered Al. Stockbridge 600 0.5	ACSR 397,500 26/7 0.5464 600 H None 15.5 750 1,500 11 (60 F) 3,500 32 4.83 Tapered Al. Stockbridge 600 0.5
1,350 (Calc.) D 9 D 10 D 10 Not available 650	1,350 (Calc.) D 9 D 10 D 10 Not available 650	1,350 (Calc.) D 9 D 10 D 10 Not available 650	930 D 10 D 12 D 12 280 650	930–1,330 D 10-S D 12-10 D 12-10 280–680 650	1,200 D 8 x 780 BIL D 8 x 780 BIL D 10x945 BIL 650	1,200 D 8 x 780 BIL D 8 x 780 BIL D 10x945 BIL 650	1,200 D 8 x 780 BIL D 8 x 780 BIL D 10x945 BIL 650	1,200 D 8 x 780 BIL D 8 x 780 BIL D 10x945 BIL 650	1,000 D 12 x 5.0 None None D 11 x 7.0 None 650	1,000 D 12 x 5.0 None None D 11 x 5.0 7% 550	1,490 D 10 x 590 dry D 12 x 690 dry D 12 x 690 dry 650	1,490 D 10 x 590 dry D 12 x 690 dry D 12 x 690 dry 650
1 ⅜ in. ..... 43 Unknown L S Not available 138 Grd Y None None None None Carr. 5 15	2 ⅜ in. ..... 43 Unknown L S Not available 138 Grd Y None None None None Carr. 5 15	2 ⅜ in. ..... 43 Unknown L S Not available 138 Grd Y None None None None Carr. 5 15	1 ⅜ EHS St 45 29 Unknown None S Unknown None .... Ph. Comp. 5 25	1 & 2 ⅜ EHS St 45–27 29–18 Unknown None S Unknown 121 .... Z Carr. Pilot 5 25	2 5/16 HS St 34 10.5 20 to 1,000 ..... S ..... 121 ..... 24 ..... Z Carr. Dir. Gnd 8 Insta	2 5/16 HS St 34 12.0 5 to 50 ..... S ..... 121 ..... 24 ..... OC Gnd 15	2 5/16 HS St 34 13.3 5 to 50 ..... S ..... 145 .... OC Gnd 15	2 5/16 HS St 34 13.3 5 to 25 ..... S .... 24 .... Dir. OC 8	2 1-in. HS St None 18 Not measured None S None 121 None 55(DE only) None None Dir. Comp. Carr. 5 No reclo.	2 ½ HS St None 18 Not measured None X 0.5 109 & 121 None 55(DE only) None None Ph. Comp. Carr. 3 No reclo.	2 ⅜ EHS St 38.5 8.5 1 to 10 None S ..... 145 None None 33 None Dist. Carr. 5 17–19	2 ⅜ EHS St 38.5 8.5 1 to 10 None S ..... 145 None None 33 None Dist. Carr. 5 17–19
3 15 One only on system	3 15 One only on system	3 15 One only on system	.... 39,600 ..... None	.... 7,920 ..... None	0.8	0.8	0.8	0.8	None None None None None None	None None None None None None	..... None None None None None	..... None None None None None
No 50 to 150	No 50 to 150	No 50 to 150	None 110 & 130 None None	None None None None	..... 110	.... 72.70 & 75.54	....	....	None Relay only None None	None Relay only None None	None 50–150 None None	None 50–150 None None

151-200 kv Characteristics of Typical Modern

Region	WEST NORTH CENTRAL							SO. ATL.	E. SO. CENTRAL		
Company	Iowa Illinois G&E Co	Union Elec Co of Mo.	Kansas City Power & Light Co		Empire Dist. Elec Co	St. Joseph Light & Power Co	Kansas Gas & Elec Co	Georgia Power Co	Tenn. Valley Authority		
Line designation (Name or No.)	Des Moine-Ft. Dodge	Osage-Moberly	St. Joseph-Paola	Moberly	Riverton-Aurora	Power Pool	Omaha-Midian	Atkinson-E. Point	Typical	Typical	Typical
Voltage (nominal)-kv	161	161	154	154	161	161	154	154(115)kv	154	154	154
Frequency-cps	60	60	60	60	60	60	60	60	60	60	60
Length-miles	80	85.8	111	103	57.07	64.2	268.5	12.969	Approx.50	Approx.50	Approx. 50
Originates at	Des Moines	Osage SS	St. Joseph; Mo.	Kansas City	Riverton Kan.	St. Joseph; Mo.	Midian SS	Atkinson Sta.	.....	.....	.....
Terminates at	Ft. Dodge	Moberly SS	Paola, Kan.	Moberly; Mo.	Aurora	State line	South Omaha	East Point SS	.....	.....	.....
Year of constr. (or recons)	1949	1952 (New)	1947	1952	1947–8	1948	1942	1945	1952	1951–2	1950
Rating per cct.-Mva	50 (2L-6)	100	50	75	50	65	40	45	.....	.....	.....
STRUCTURES											
(S)teel, (W)ood, (A)lum.	W	W	W	W	W	W	W	W	S	S	W
Av. No. per mile	8	7	8.1	7.0	8.8	8	9	7.02	4.6	4.61	7.7
Types (S)q, (A)-or, (H)-frame*	H	H (W-12)	H (W-4)	H (W-12)	H (W-10)	H	H	H (W-10)	S (S-16)	S (S-16)	H (W-10)
Min. flashover-60cps kv	490 wet	840/565	415	415	415	415	765	295	.....	.....	.....
No. of cir. (D)nst. (P)rov.	1	1	1	1	1	1	1	1	1	1	1
Crossarms, (W)ood, (S)teel, (A)lum.	W	W	W	W	W	W	W	W(Dbl plank)	S	S	W
Bracing (S)teel, (W)ood	W	W	W	W	W	W	W	None	.....	.....	.....
Aver. weight per struc.-lb	6,000	7,500	7,050	7,600	4,985	.....	6,600	.....	12,430	12,430	.....
Insul. in guys (W)ood, (P)orc.-Kv	W-325	W	W-66	W-66	None	W	W	W-700	.....	.....	.....
CONDUCTORS											
C, A, S, ACSR, Cw (H)ollow	ACSR	ACSR	H & ACSR	ACSR	ACSR	ACSR	C-H	ACSR	ACSR	ACSR	ACSR
Diam, Cir mil or Gage	397,500	556,500	250,000–397,500	556,500	336,400	397,500	0.683 in. 250,000	397,500	795,000	636,000	636,000
Stranding	26/7	26/7	12, 26/7	26/7	30/7	26/7	12	26/7	26/7	26/7	26/7
Weight per ft-lb	0.5464	0.765	0.782–0.5464	0.765	0.527	0.546	0.7827	0.5472	1.094	0.875	0.875
Designed for—amp	600	550	580	730	.....	360	580	.....	.....	.....	.....
Ph. config. (V)ert, (H)or, (T)riang	H	H	H	H	H	H	H	H	H	H	H
Cond. offset from Vert.-ft	None	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Phase separation-ft	15.5	15.5	15.5	15.5	14.5	15.5	14.5	16.	20.67	20.67	17.5
Span, normal-ft	750	1,000	655	755	600	660	590	750	1,180 (1,146.1)	1,180 (1,140.6)	575 (687.4)
Span, max.-ft	1,500	1,460	1,157	1,160	1,450	1,000	1,200	1,275	2,264.8	2,078.2	2,446.5
Sag final-ft at deg F	11 (60F)	22.5 (60F)	20.0–13.5 (60F)	14.5 (60F)	45 (90F max)	14 (60F)	13.58	14.0 (750 span)	39 (120F)	39 (120F)	11 (120F)
Tension corresponding	3,500	9,500 max	2,740–2,900	4,140	2,880	2,990	2,600	2,766 (6,450 max)	4,940	3,920	3,300
Min. clear. to ground-ft	32	28	31.0	30.0	29	25	27 (120F)	25	25	25	25
Min. clear. to struct-ft	4.83	3.0	4.25	4.25	6	3.5	3	7.5	4	4	3.5
Type armor at clamps	Tapered A1	Preformed	Tprd Rods	Preformed	Tapered	Tapered A1	None	Rods	Tapered A1	Tapered A1	Tapered A 1
Type vibration dampers	Stockbridge	None	None	None	Stockbridge	None	None	Stockbridge (D.E.)	Stockbridge	Stockbridge	.....
Line altitude range-ft	600	575 to 1,000	750 to 1,100	650 to 1,050	900 to 1,400	800 to 1,200	1,300	750 to 1,015	847 max	2,046.5 ma	2,339 max
Max. corona loss-kw/3-ph. mi	0.5	None	0.20	0.10	5.22	.....	0.5	Negl.	.....	.....	.....
INSULATION											
Basic imp. insul level-kv	1,490	1,425	1,000	1,000	1,425	1,500	1,280	1,460	.....	.....	.....
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	10 x 590 dry	10	10 x 80	10 x 80	10 x 5.75	10 x 415	10	7 x 5.75	11 x 5.75	11 x 5.75	11 x 5.75
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D	D	D
No. units and kv rating (or in.)	12 x 690 dry	12	12 x 80	12 x 80	16 x 5.75	10 x 415	16	12 x 5.75	11 x 5.75	11 x 5.75	13 x 5.75
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D(Dbl str).	D(Dbl str.)	D(Dbl str.)
No. units and kv rating (or in.)	12 x 690 dry	12	10 x 80	10 x 80	16 x 5.75	12 x 4.15	16	7 x 5.75	14	14	14
Impulse reduction-kv or %	.....	None	0	0	None	.....	.....	1,110	.....	.....	.....
BIL of term. apparatus-kv	650	650	650	650	650 & 750	650	865	550	750	750	750
IMPULSE SURGE PROTECTION											
No. of ground wires	2	2	2	2	2	2	2	2	2	2	2
Grd. wire matl. and size	⅝ EHS St.	⅝ EHS St.	⅝ EHS St. 11/32HS Cw	⅝ EHS St.	⅝ EHS St.	⅝ EHS St.	⅜ St.	⅝ St.	7/16 HS St	7/16 HS St	7/16 HS St
Angle of prot-deg	38.5	30	30	30	30	30	30	32	20	20	30
Grd. wire clear. mid-span-ft	8.5	23.3	18.5	18	18	22	20.58	18.0	25	25	17
Grd. res. range-ohms	1 to 10	10 max	Under 10	Under 10	unknown	2 to 10	2 to 25	5 to 15	1 to 61	1.5 to 130	4 to 560
Counterpose (L)inear, (C)rowfoot	None	None	None	None	None	C	None	C	None	None	None
Neut. gdg. (S)olid, (R), (X), (T)ransf	S	S(1 end)	S & T	S & T	S	S	S	S	$X_0/X_1<3.0$	$X_0/X_1<3.0$	$X_0/X_1<3.0$
Neut. gdg. (equiv. ohms)	.....	0	0.025–0.6	0.025–0.6	None	.....	5	.....	.....	.....	.....
Arrester rating-kv	145	169	145	145	145	145	.....	97 (115 kv)	145	145	145
Expulsion tube gap-in	None	None	None	None	None	.....	.....	121	.....	.....	.....
Arcing horn gap-in	None	None	42	42	None	.....	26	None	.....	.....	.....
Arcing ring top diam-in	33	None	33	33	None	.....	.....	None	.....	.....	.....
Arcing ring bot. diam-in	None	None	None	None	None	.....	.....	None	.....	.....	.....
Type relaying	Dist. Carr.	Dir. Comp. Carr.	Dir. Comp. Carr.	Dir. Comp. Carr.	Dist. Carr. Carr.	HZM Carr.	Carr.	Pilot Wire	Adm. Carr.	Adm. Carr.	Adm. Carr.
Breaker interruption-Cycles	5	3	3–5	3	5	5	5	5	3	3	3
Reclosure delay-cycles	17–19	20	17–20	20	20	None	20	900 (Man)	0	0	0
VOLTAGE REGULATION											
Nominal-%	.....	±5	20	20	.....	20% TCUL	5	.....	.....	.....	.....
Synch. cond.-kva	None	None	None	None	None	None	None	.....	.....	.....	.....
Synch. cond. spacing-miles	None	None	.....	.....	None	.....	.....	.....	.....	.....	.....
Shunt cap.-kva	None	None	None	None	None	None	None	.....	.....	.....	.....
Shunt cap. spacing-miles	None	None	.....	.....	None	.....	.....	.....	.....	.....	.....
Series capacitor-kva	None	None	None	None	None	None	None	.....	.....	.....	.....
COMMUNICATION											
Telep circ on struct	None	None	None	None	None	.....	.....	None	None	None	None
Carrier Frequency-kc	50–150	67.5	50	106 & 160	111	50	70	.....	50–200	50–200	50–200
Pilot wire	None	No	No	No	None	.....	.....	.....	Little	Little	Little.
Microwave-Mc	None	1,945–1,985	No	No	None	.....	.....	.....	2,000	2,000	2,000

* Parentheses refer to configuration diagrams on page 150.

Transmission Lines

➧ 201-250 kv

	MOUNTAIN			NEW ENG.	MIDDLE ATLANTIC					E. NO. CENTRAL		
Louisville Gas & Elec Co	Montana Power Co	Bur. of Reclamation	Utah Power & Light Co	Boston Edison	Philadelphia Electric Co		Penna. P & L Co	Penna. Elec Co	Metro. Edison Co	Commonwealth Edison Co		
TVA line	Anaconda-Grace	Typical line	Grace-Goshen	55-508	B-130-28	22,001-22,003	Sunbury-Siegfried	Shawville-Montebello	Hosensack-Montebello	8301 (1-cct. port)	8301 (2-cct. port)	8301(Total)
154	161	161	161	305-509	132	220	220	230	230	230	230	230
				110 (220 Future)	(220 Design)							
60	60	60	60	60	.....	60	60	60	60	.....	.....	60
67	273.9	.....	57.24	21.80	56	each 57.7	753	87	105	130	17	147
Louisville, Ky	Anaconda	.....	Grace Sta.	Weymouth	Emilie	Plymouth Meeting	Sunbury Sta.	Shawville	Hosensack	.....	.....	Powerton
Summershade	Grace, Idaho	.....	Goshen SS	Walpole	Burlington N.J.	Conowingo	Siegfried SS	Montebello	Montebello	.....	.....	Crawford Sta.
1941	1940-1941	.....	1940-1941	1952	1952	1928	1947-1952	1952-1953	1952-1954	.....	.....	1940
120	50	.....	50	135	256	426	175	250	250	.....	.....	188
S	W	W	W	S	S	S	S	S	S	S	S	.....
6	7.5	8	7.75	6.7	6.0	4.5	4.6	4.95	4.1	4.9	7.5	.....
S	H (W-1)	H (W-3)	H (W-1)	S (S-10)	S (S-19)	S (S-18)	S (S-15)	Twer (S-16)	Rect. (S-18)	S (S-17)	S (S-17)	(S-17)
490	.....	455	350	785/565	415	635	785/585	.....	635	865	865	.....
2	1	1	1	2	1	1	1	1	1	1	(I)-1, (P)-2	.....
S	W	W	W	S	S	S	S	S	S	S	S	.....
S	W	W	.....	S	S	S	.....	S	.....	S	S	.....
18,800	.....	6,500	3,000	17,200	28,800	20,800	12,500	14.250	12,000	23,780	39,560	.....
None	None	.....	.....	.....	.....	.....	None	.....	.....	No guys	No guys	.....
HD copper	H	ACSR	C (H)	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	.....	.....	ACSR
500,000	250,000	477,000	250,000	795,000	795,000	795,000	1.14	1,033,500	795,000-1,033,506	.....	.....	900,000
19	18	26/7	7 Segs.	54/7	30/19	30/19	30/19	54/7	30/19-54/7	.....	.....	54/7
1.544	0.7869	0.6557	0.763	1.026	1.237	1.237	1.234	1.33	1.237-1.330	.....	.....	1.158
780	.....	.....	280	700/800	1,120	1,120	840	625	1,060	.....	.....	494
V	H	H	H	V	H	H	H	H	H	H	V	.....
2.8	.....	.....	.....	3.0	.....	.....	.....	.....	.....	.....	4.0	.....
14.5	13.5	17	13.5	14.25 to 15.75	25.5	25.5	26.25	28.0	26.0	33.33	20.58	.....
850	650	700	700	695	900	1,175	1,100	1,070	1,200	1,200	800	.....
1,775	1,955	1,900	1,250	2,003	1,967	2,180	2,740	2,950	2,069	1,275	1,095	.....
— (120F)	19 (60F)	14.37 (60F)	17.5 (60F)	.....	16.5 (60F)	34 (60F)	34 (120F)	36.6 (120F)	44.5 (120F)	38.6	16.6	.....
.....	2,500	2,790	2,680	7,500	7,510	6,300	5,500	5,400	5,500	3,470	4,400	.....
30	25.5	29	25	25 (120F)	35.0	31.5	30.0	30.0	30 (120F)	27.5	37.0	.....
7	3.5	5.6	6	6.42 (30°swg)	8.0	8.0	8.0(30°swg)	7.0(30°swg)	8.0	8.58	9.0	.....
.....	None	Tapered	.....	A1	TaperedA1	TaperedA1	TaperedA1	Preformed	Preformed	.....	.....	TaperedA1
.....	None	Stockbridge	.....	Stockbridge (Xing)	None	None	None	None	None	.....	.....	Stockbridge
460 to 1,020	6,823 to 4,400	.....	4,570 to 6,350	5 to 39	40 to 100	50 to 650	370 to 1,730	600 to 2,200	200 to 1,400	.....	.....	700
.....	.....	0.6	0.30	.....	0.09	0.6	.....	.....	None	.....	.....	.....
750	.....	1,425	1,200	.....	945	1,425	1,420	1,440	1,425	.....	.....	1,585
D	D	D	D	D	D	D	D	D	D	.....	.....	D
12	8	11 x 640 dry	8 x 780 BIL	14	10 (132 kv)	16	16	16	16 x 635	.....	.....	18
D	D	D	D	D	D(Dbl str)	D	D	D	D	.....	.....	D
12	9	13 x 735 dry	8 x 780 BIL	16	16 (220 kv)	16	18	16 or 18	18 x 705	.....	.....	20
D	D	D	D	D	D(Trpl str)	D(Trpl str)	D	D	D	.....	.....	Pedestal
12	9	13 x 735 dry	10x945 BIL	7(110kv)	12 (132 kv)	18	14 x 1,265	18	18 x 705	.....	.....	8(86 in gap)
.....	.....	.....	.....	48°	41.8°	36.8°	155	.....	.....	.....	.....	.....
750	161	.....	750	.....	550 (132 kv)	900	900	900	900	.....	.....	1,300
2	None	2	0	2	2	2	2	2	2	2 (Stkbdge)	2 (Stkbdge)	.....
3/8 St	.....	3/8 HS St	.....	5/8 HS St	7/16EHSSt	163,600 ACSR	1/2 EHS St	1/2 St	7/16EHSSt	1/2 EHSCw	1/2EHSCw	.....
30	.....	45	.....	9	16	37	30	17	30	15 to 19	0	.....
20	.....	11.5	.....	16	19	24	29	29	25-28.5	40	31	.....
5 to 20	.....	5 to 20	.....	.....	3 to 28	.....	10	.....	15 opt.	.....	.....	5 max
.....	None	None	.....	L	C	L or C	L	L(cont.)	L or C	.....	.....	L(occasion)
S	S	S	S	S	S	S	S	S	S	.....	.....	S
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
145	None	.....	145	.....	121 (132 kv)	220 & 185	195	196	196	.....	.....	206 & 195
.....	None	None	.....	.....	.....	.....	None	.....	.....	None	None	None
.....	.....	None	35	.....	.....	36	None	.....	.....	None	None	None
.....	.....	None	.....	.....	.....	36	None	.....	.....	None	None	None
.....	.....	None	.....	.....	.....	36	None	.....	.....	None	None	None
Dir. Dist.	Dist. Dir. Gnd. Carr.	Dist. & OC	Z Carr. Dir. Gnd.	Mod. Z Carr.	Dir. Comp. Carr.	Dir. Comp. Carr. Z & Dir. OC	Carr.	Carr.	Carr. Dist. & Dir. OC Gnd.	.....	.....	Carr.
5	5	5	5	5	5	5 & 10	3	3	5	8	5	.....
20	Not used	20	Inst.	None	No reclo.	No reclo.	120	17	Fast	.....	.....	Not used
10	7	.....	5.1	.....	4.5	5	5	.....	.....	.....	.....	0 to 5
.....	None	.....	.....	.....	.....	90,000	.....	.....	.....	.....	.....	75,000
.....	.....	.....	.....	.....	.....	Rec. end	.....	.....	.....	.....	.....	Rec. end
.....	None	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	None
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	None	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	None
.....	.....	None	.....	.....	.....	.....	None	.....	.....	.....	.....	None
65 & 90	.....	30-215	138 & 154	145	140	138	Yes	.....	.....	.....	.....	104 & 136.5
.....	.....	None	.....	.....	.....	.....	None	.....	.....	.....	.....	None
.....	.....	None	.....	.....	.....	.....	None	.....	.....	.....	.....	None

Characteristics of Typical Modern Transmission Lines

	E. NO. CENTRAL	W. NO. CENTRAL		SO. ATLANTIC		MOUNTAIN			PACIFIC	
Company	Central Illinois P.S. Co	North. States Power Co	Union Elect Co of Mo.	Pennsylvania Water & Power Co		Idaho Power Co	Bureau of Reclamation		Pacific Gas & Electric Co	
Line designation (Name or No.)	.....	Black Dog-Valley	Cahokia-W. Frankfort	2305	2302/2303	Boise-Bliss Falls	Typical 1-cct.	Typical 2-cct.	Sunol-Moss Ldg	Panoche-McCall
Voltage (nominal)-kv	230	230	230	66(230 Fut.)	230	138(230 Fut.)	230	230	220	220
Frequency-cps	60	60	60	60	60	60	60	60	60	60
Length-miles	48	114.22	88.7	32.56	142.45	189.1	.....	.....	61.6	55.6
Originates at	Joppa	Minneapolis	Cahokia	Safe Harbor	Safe Harbor	Boise	.....	.....	Sunol	Panoche SS
Terminates at	W. Frankfort	Granite Falls	W. Frankfort SS	Hummels-town	Balto. & Wash.	American Falls	.....	.....	Moss Ldg. Sta.	McCall SS
Year of constr. (or recons)	1951–1952	1951–1952	1952	1952	1931/31/37	1949–1950	.....	.....	1949–1950	1952
Rating per cct.-Mva	300	133	300	250	250	180	.....	.....	175	175
STRUCTURES										
(S)teel, (W)ood, (A)lum	W	S	W	S	S	W	S	S	S	S
Av. No. per mile	9.0	4.0	8.0	5.16	5.28	8.25	4.5	5.0	4.35	4.85
Types (S)q, (A)-or (H)-frame*	H (W-5)	(S-16)	H (W-5)	S (S-16)	S (S-16)	H (W-14)	S (S-10)	S (S-16)	(S-1)	(S-5)
Min. flashover-60 cps kv	600 (wet)	.....	1,080/825	.....	.....	820	635	635	.....	.....
No. of circ. (I)nst. (P)rov	1	1	1	1	1	1	1	2	2	(I)-1, (P)-2
Crossarms, (W)ood, (S)teel, (A)lum	W	S	W	S	S	W	S	S	S	S
Bracing (S)teel, (W)ood	W	S	W	S	S	W	S	S	None	None
Aver. weight per struc.-lb	10,000	.....	10,000	10,910	11,912	.....	15,200	27,150	16,500	13,650
Insul. in guys (W)ood, (P)orc.-Kv	W	.....	W	None	None	W	.....	.....	None	None
CONDUCTORS										
C, A, S, ACSR, Cw, (H)ollow	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR
Diam, Cir mil or Gage	954,000	795,000	954,000	795,000	795,000	715,500	954,000	795,000	795,000	795,000
Stranding	54/7	26/7	54/7	26/7	30/19	26/7	54/7	26/7	54/7	54/7
Weight per ft-lb	1.227	1.094	1.23	1.094	1.234	0.984	1.227	1.098	1.026	1.026
Designed for —— amp	1,000	.....	800	900	910	700	.....	.....	.....	.....
Ph. config. (V)ert, (H)or, (T)riang	H	H	H	H	H	H	H	V	V	V
Cond. offset from Vert.-ft	.....	.....	.....	.....	.....	.....	.....	8.0	None	None
Phase separation-ft	22.0	27.83	22.0	26.5	28.25	20.0	26.0	24.25	16.5	16.5
Span, normal-ft	600	1,300	800	1,150	1,000	660	1,150	1,050	1,200	1,200
Span, max.-ft	827	1,725	1,512	2,050	2,200	2,070	2,130	1,350	2,851	1,389
Sag final-ft at deg F	9.7 (600 ft)	45.0 (120 F)	17.4 (60 F)	26 (60 F)	26.5 (60 F)	12.2 (120 F)	36.6	27.7	192 (60 F)	45.5 (60 F)
Tension corresponding	5,100	5,220	12,000 max	5,300	5,790	4,400	5,600	5,500	5,420	5,420
Min. clear. to ground-ft	30.65	33	30	32.0	32.0	30.0	33.0	33.0	30.0	30.0
Min. clear. to struct-ft	6.25	.....	5	18.0	20.0	8.0	9.0	9.0	5.5	5.5
Type armor at clamps	Tapered Al	Tapered Al	Tapered	Alcoa	Alcoa	Tapered Al	Tapered	Tapered	Rods	Rods
Type vibration dampers	Stockbridge (DE)	Stockbridge (DE)	Stockbridge (DE)	None	None	Tang. only	Stockbridge	Stockbridge	Stockbridge	Stockbridge
Line altitude range-ft	380 to 600	700 to 1,100	400 to 500	450 to 650	0 to 750	2,700 to 4,500	.....	.....	0 to 2,383	173 to 482
Max. corona loss-kw/3-ph. mi	.....	.....	None	Neg.	Neg.	1.0	1.0	1.0	Small	Small
INSULATION										
Basic imp. insul. level-kv	1,780	.....	2,090	1,415	1,415	2,170	1,425	1,425	.....	.....
Tangent, (D)isk, (P)in, (L)ine-post	D	D	D	D	D	D	D	D	D (Fog)	D
No. units and Kv rating (or in.)	15 x 5.75	16	15	16 x 5.75	20 x 5.25	14	16 x 875 dry	16 x 875 dry	13 x 6.5	15 x 5.75
Angles, (D)isk, (P)in, (L)ine-post	D	D	D	D (Dbl str.)	D (Dbl str.)	D	D	D	D	D
No. units and kv rating (or in.)	17 x 5.75	.....	17	18 x 5.75	20 x 5.75	16	16 x 875 dry	16 x 875 dry	20 x 7.0 (HS)	15 x 7.0 (HS)
Term. (D)isk, (P)in, (L)ine-post	D	D	D	D (Dbl str.)	D (Dbl str.)	D	D	D	D	D
No. units and Kv rating (or in.)	17 x 5.75	18	17	18 x 5.75	20 x 5.75	16	17 x 920 dry	17 x 920 dry	20 x 7.0 (HS)	15 x 7.5 (HS)
Impulse reduction-kv or %	.....	.....	None	None	None	1,520	.....	.....	.....	.....
BIL of term. apparatus-kv	1,050	1,050	900	900 (230 kv)	1,050	650 (138 kv)	.....	.....	.....	.....
IMPULSE SURGE PROTECTION										
No. of ground wires	2	2	2	2	2	None	2	2	None	1
Grd. wire matl. and size	⅜ EHS St	7/16 St	⅜ EHS St	7/16 St	203,200 ACSR ⅜ Cw	.....	½ HS St	½ HS St	.....	⅜ HS St
Angle of prot-deg	36	17 & 39.5	35	17.6	17	.....	20	5	.....	42
Grd. wire clear., mid-span-ft	19.5 (600 span)	37 (1,400 span)	182	28.4	30.0	.....	29.5	26.5	.....	35
Grd. res. range-ohms	15	0.1 to 20	10 max	14 opt.	25 opt.	3.5 to 200	5 to 20	5 to 20	.....	.....
Counterpoise (L)inear, (C)rowfoot	None	None	None	C & L	C & L	None	None	None	None	None
Neut. gdg. (S)olid, (R), (X), (T)ransf	S	S	S	S	.....	S	S	S	S	S
Neut. gdg. (equiv. ohms)	0	0	0	.....	.....	.....	.....	.....	.....	.....
Arrester rating-kv	183	195	195	196	230	121	.....	.....	None	None
Expulsion tube gap-in	None	None	None	None	None	.....	None	None	None	None
Arcing horn gap-in	None	None	None	None	None	.....	None	None	None	None
Arcing ring top diam-in	None	None	None	None	None	.....	None	None	None	None
Arcing ring bot. diam.-in	None	None	None	None	None	.....	None	None	None	None
Type relaying	DZ, DG, Pilot	Z-Carr. Gnd.	Ph. Comp. Carr.	Carr. Dist.	Carr. Dist.	Z, Carr. Pilot	Dist. & OC	Dist. & OC	Z-Gnd. Carr.	Z & Gnd.
Breaker interruption-cycles	5	6	3	3	8	5	3	3	3	3
Reclosure delay-cycles	15	180	20	20	.....	25	20	20	28	None
VOLTAGE REGULATION										
Nominal-%	.....	5	±2.5	TCUL rec. end	TCUL rec. ends	.....	.....	.....	.....	.....
Synch. cond.-kva	None	.....	None	None	None	.....	.....	.....	.....	.....
Synch. cond. spacing-miles	.....	.....	None	None	None	.....	.....	.....	.....	.....
Shunt cap.-kva	10,000	.....	None	None	None	.....	.....	.....	None	None
Shunt cap. spacing-miles	Rec. end	.....	None	None	None	.....	.....	.....	None	None
Series capacitor-kva	None	.....	None	None	None	None	.....	.....	None	None
COMMUNICATION										
Telep circ on struct	None	.....	None	None	None	None	None	None	None	None
Carrier frequency-kc	None	135	131–155	160	63	62.5	30–215	30–215	60 & 110	None
Pilot wire	None	.....	None	None	None	1	None	None	None	None
Microwave-Mc	6,800	.....	1,935–1,975	None	None	None	None	None	None	None

* Parentheses refer to configuration diagrams on page 150.

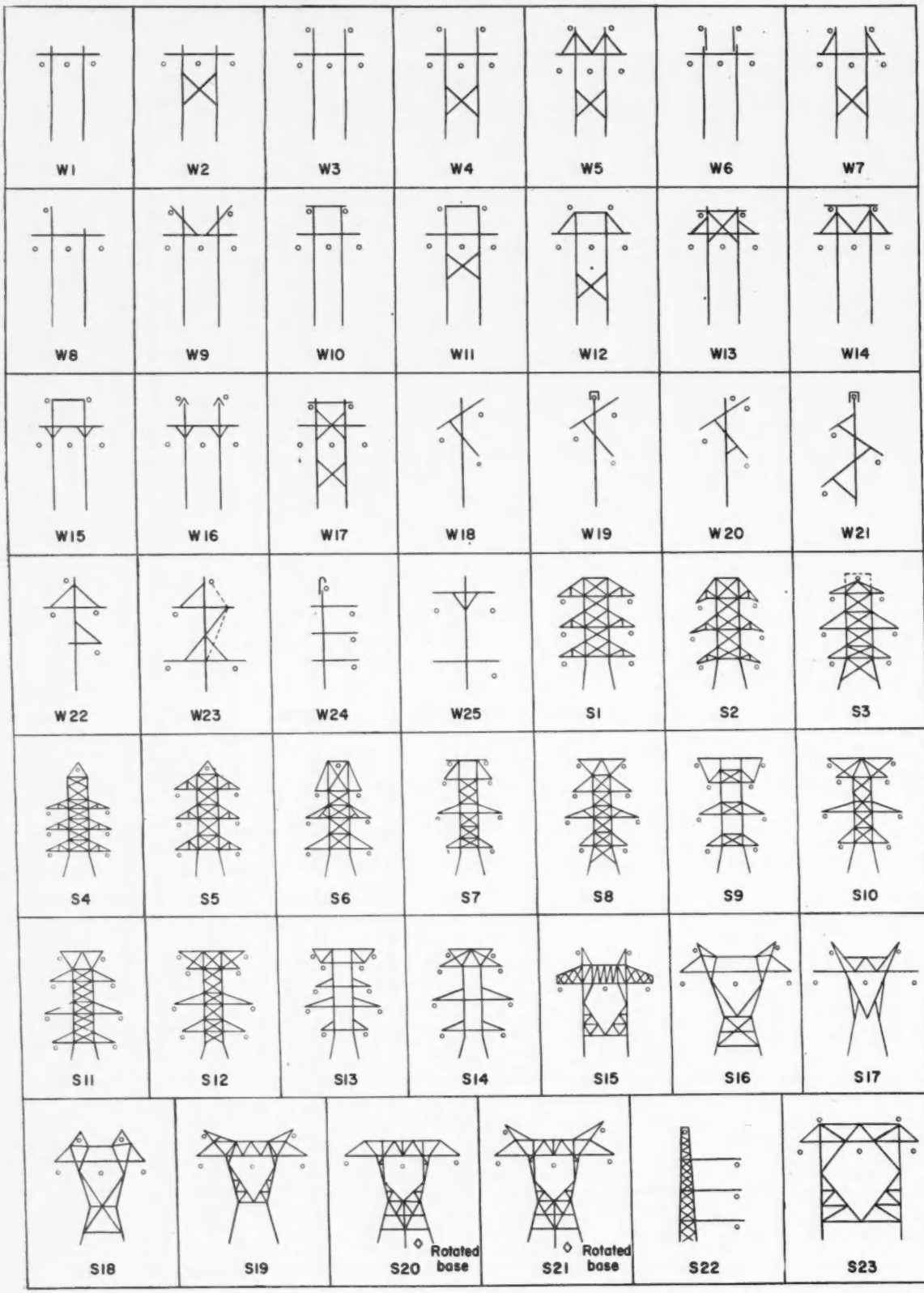
in the United States ➧ 201-250 kv | 251-300 kv | 301-400 kv

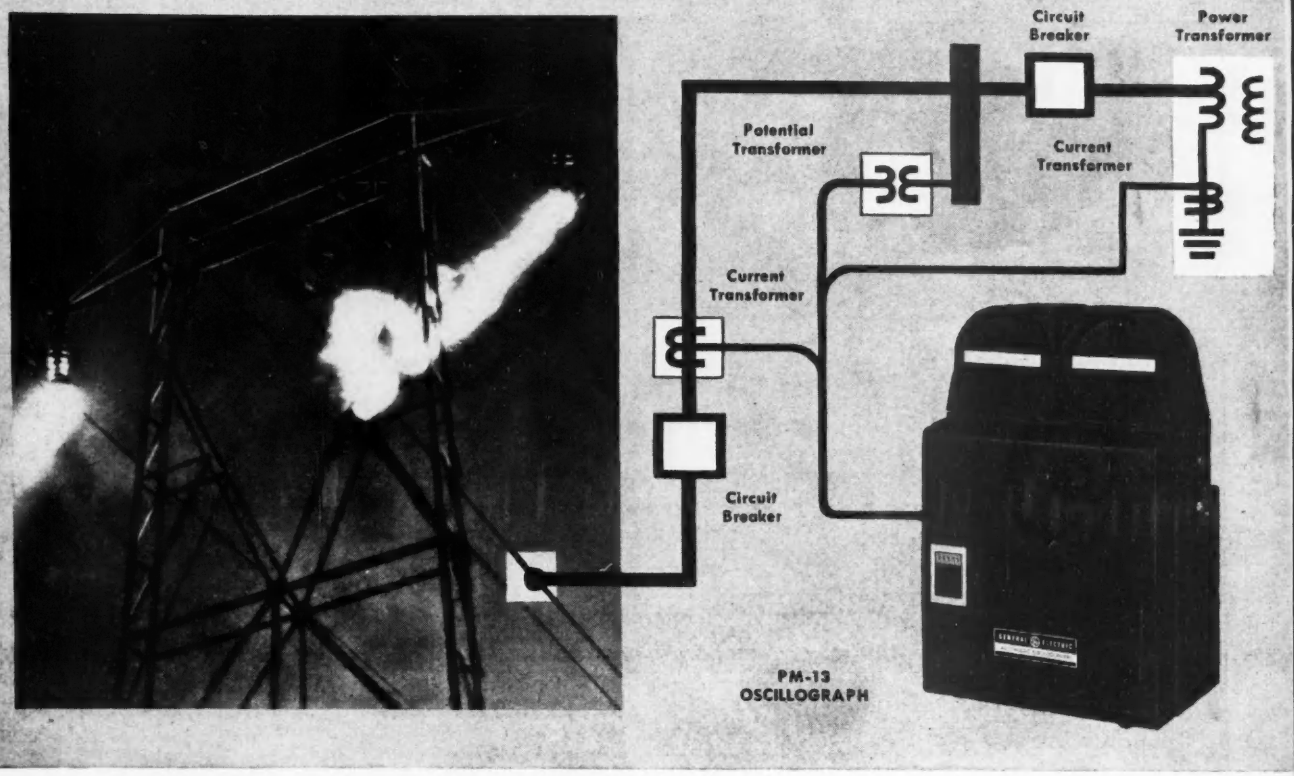
PACIFIC									PACIFIC		SO. ATL.	PAC.
So. Cal. Edison Co	L. A. Dept of W & P	Washington W.P. Co	Seattle Dept of Lighting		Bonneville Power Administration Portland, Oregon				L. A. Dept of W & P	Bonneville P. Adm.	American G & E	Bonneville P. Adm.
Megunden-Mesa	Owens Gorge	Cabinet 230-kv	Skagit No. 1 (Ross-Gorge)	Skagit No. 1 (Gorge-Bothell)	Olympia-Covington	Midway-Coulee No. 1	Coulee-Spokane 3 & 4	Chehalis-Olympia	Boulder I, II, III	Coulee-Columbia No. 3	Spurn-Kanawha	McNary-Ross
220	230*	230	230	230	230	230	230	230	287.5**	300	330	345
60	60	60	60	60	60	60	60	60	60	60	60	60
119.5	260.5	77.3	9.24	81.5	59.85	100	83	30.24	263.7 ea.	76.3	63	.....
Megunden	Owens Gorge	Cabinet Gorge	Ross	Diable	Olympia SS	Midway SS	Gr. Coulee	Chehalis	Hoover Dam	Gr. Coulee	Graham Sta. W. Va.	McNary
Mesa	Taluca Rec.	Spokane	Diable	Bothell	Covington SS	Gr. Coulee	Spokane SS	Olympia SS	Los Angeles	Columbia SS	Glasgow, W. Va.	Ross SS
1950 (New)	1951	1952	1952 (New)	1952 (New)	1950 (New)	1941 (New)	1943 (New)	1949 (New)	I & II-1936, III 1940	1950 (New)	1951	New
200	120	220	180	180	.....	.....	.....	.....	160	.....	500	.....
S	S	W	S	S	S	S	S	W	S	S	S	S
3.9	4.9	7.6	3.35	4.5	4.9	4.8	5.1	9.2	5.5	4.7	4.1	.....
S (S-23)	S(S-8, S-16 rot. base)	H (W-2)	S (S-2)	S (S-2)	S (S-20)	S (S-21)	S (S-21)	H (W-2, K or X)	S (S-8, S-16, rot. base)	(S-20)	S (S-3)	(S-21)
595	535	.....	565	565	565	615	630	970 (wet)	800	615 (wet)	690 (wet)	.....
1	1	1	2	2	1	1	2	1	1	1	(I)-1, (P)-2	.....
S	S	W	S	S	.....	.....	.....	.....	S	.....	S	.....
S	S	W	S	S	.....	.....	.....	W	S	.....	S	.....
9,390	13,469	.....	33,000	22,000	12,642	14,968	18,608	.....	I & II 18,200 III 20,000	14,636	28,000	23,846
No guys	No guys	None	None	No guys	None	None	None	W	None	None	.....	.....
ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR	ACSR-Hol. Cu.-Hol. Cu. Cw.	ACSR	Hol. Cu.	ACSR	ACSR	.....
605,000	954,000	795,000	795,000	795,000	795,000	795,000	795-500-500 Mem	795,000	1.4-500,000	1,272,000	1,275,000	.....
30/19	54/7	26/7	30/19	30/19	26/7	.....	26/7-Var.	26/7	10 Segments	54/19	54/19	.....
0.939	1.227	1.098	1.237	1.237	1.098	1.098	1.093-1.565	1.093	1.566	1.636	1 874	.....
.....	1,010	600	800	800	450	450	450	450	1,020	550	1,600	825
H	H	H	V	V	H	H	V	H	H	H	V	.....
.....	.....	.....	3.5	3.5	.....	.....	3.5	.....	.....	.....	5.0	.....
23.0	26.0	19.25	18.82	17.35	27.0	27.0	20.25	20.0	32.5	27.0	21.5	.....
1,350	1,130	600	1,150	1,150	1,200	1,500	1,200	700	1,000	1,500	1,400	.....
2,974	2,080	2,575	3,218.39	3,235	1,786	.....	.....	1,410	2,197	3,590	2,800	.....
Varies	44.0 (60 F)	12 (60 F)	235 (100 F)	241 (100 F)	.....	.....	.....	.....	40 (60 F)	.....	70 (120 F)	.....
7,000	4,450	4,100	6,814	6,714	12,000 max	12,000 max	10,000 max	8,000 max	4,370	16,700 max	7,000	.....
30.0	27.0	32.0	30.0	30.0	29.5	29.5	29.5	29.5	27.0	32.4	35.0	.....
6.0	7.25	4.0	5.0	5.0	6.0	6.0	.....	4.5	11.0	6.0	7.75	.....
Al	Tapered	Preformed	Tapered	Tapered	Tapered	Tapered	Tapered on ACSR	Tapered	None	Tapered	Al	.....
Stockbridge	Stockbridge	Preformed	None	None	Stockbridge	Stockbridge	Stockbridge	Stockbridge	Stockbridge	Stockbridge	Stockbridge	.....
220 to 5,500	620 to 6,590	1,900 to 4,750	590 to 2,280	100 to 1,400	.....	.....	.....	.....	100 to 4,860	.....	700 to 1,600	.....
.....	0.5	1.0	1.0—	1.0—	.....	.....	.....	.....	0.7	.....	1–2 dry	.....
1,050	1,290	1,100	1,265	1,265	1,265	1,425	1,425	1,100 + Wood	1,870	1,425	1,585	1,665
D (& Fog)	D	D	D	D	D	D	D	D	D	D	D	D
15 (14 Fog)	16 x 5.0	12	14 x 80 dry	14 x 80 dry	14 x 565 wet	16 x 630 wet	16 x 630 wet	12 x 490 wet	24 x 5.0	16	18 x 690 wet	19 x 720 wet
D (Dbl str.)	None	D	D	D	D	D	D	D	D	D	D	D
15	None	12	14 x 80 dry	14 x 80 dry	16 x 630 wet	18 x 690 wet	18 x 690 wet	14 x 565 wet	24 x 5.0	18 x 690 wet	18 x 690 wet	21 x 780 wet
D (Dbl str.)	D	D	D	D	D	D	D	D	D	D	D (Dbl str.)	D
15	18 x 5.0	12	16 x 80 dry	16 x 80 dry	16 x 630 wet	18 x 690 wet	18 x 690 wet	14 x 565 wet	26 x 5.0	18 x 690 wet	19 x 720 wet	21 x 780 wet
.....	None	.....	None	None	.....	.....	.....	.....	None	.....	.....	.....
850	1,050	900	900 & 825	900 & 825	900	1,050	1,050	1,050–900	1,300	1,050–900	1,175	1,175
2	2	2-end mi.	1	None	2-end mi.	2-end mi.	1-end mi.	2-end mi.	2	2-end mi.	1	.....
½ HS St	½ HS St	7/16 HS St	795,000 ACSR	.....	⅝ HS St	⅝ HS St	7/16 HS St	⅝ HS St	½ HS St	⅝ HS St	159,000 ACSR	.....
42	16.6	27	42	.....	20	.....	.....	34.7	13.4	20	33	.....
53 to 170	27	21	.....	.....	.....	.....	.....	.....	40	.....	44	.....
.....	0.85 to 75	3 to 25	100 to 500	5 to 500	.....	5 to 20	15	.....	0.8 to 7.6	3 to 15	.....	5 to 15
None	L (10% dist)	C	None	None	C	C	C	.....	L (contin.)	C	None	C
S	S	S	S	S	S	S	S	S	S or X	S	S	.....
.....	0	0	.....	.....	.....	.....	.....	.....	0.3	.....	.....	.....
None	217	196	195	195	182	196	196	196	242	182	264	265
None	None	None	.....	.....	.....	.....	.....	.....	None	.....	None	.....
None	15.5 & 80.5	None	.....	.....	38	38	38	38	110.5 & 119.5	38	.....	60
None	None	None	.....	.....	.....	.....	.....	.....	None	.....	.....	.....
None	None	None	.....	.....	.....	.....	.....	.....	None	.....	.....	.....
HKB-ICC	Dist. & OC Gnd	HKB Carr.	Z	Ph. Comp.	Ph. Comp.	Ph. Comp.	Ph. Comp.	Ph. Comp.	Dir. Comp. Carr.	Ph. Comp.	Dir. Comp. Carr.	Microwave Transf. trip
5	5	3	3	3	3	3	3	3	3	3	3	3
No reclo.	No reclo.	15	Future	Future	20	20	20	20	No reclo.	20	20 (est)	.....
.....	7	8	.....	.....	.....	.....	.....	.....	5	.....	.....	.....
.....	Adequate	None	.....	30,000	.....	.....	.....	.....	180,000	.....	.....	.....
.....	0	.....	.....	.....	.....	.....	.....	.....	Rec. end	.....	.....	.....
None	0	None	None	None	.....	.....	.....	.....	None	.....	.....	.....
.....	0	.....	.....	.....	.....	.....	.....	.....	None	.....	.....	.....
None	7,500 (Exptl)	None	.....	.....	.....	.....	.....	.....	None	36,000	.....	.....
.....	None	.....	None	None	.....	.....	.....	.....	None	.....	None	.....
.....	86	90–130	38 & 150	38–201	.....	135 & 150	67 & 79	135 & 144	90	129	30–200	.....
.....	None	None	None	None	.....	.....	.....	.....	None	.....	.....	.....
.....	None	None	1,800 & 1,940	.....	1,800	7,100	7,100	1,800	None	7,100	.....	7,100

* 12.9 mi. double circ.

** I & II 40.8 mi. double circ. II 5.6 mi. on 4-cct.

Structure Configurations Assume 48 Forms





TRANSMISSION-LINE FAULT (ACTUAL PHOTO) CAUSED BY LIGHTNING IS AUTOMATICALLY RECORDED BY GENERAL ELECTRIC OSCILLOGRAPH.

NEW FEATURES INCLUDING 7-TRACE DESIGN HELP YOU TO . . .

Analyze System Faults Easier with a G-E Oscillograph

Designed to automatically record power system transient disturbances, General Electric's new PM-13 oscillograph now makes possible seven simultaneous traces. The oscillograph records quantities pre-selected by the system engineer such as ground current, line current, phase/ground potential, phase/phase potential, and Kw or Kva.

NEW LIGHT SOURCE

A flooding-type light source illuminates all seven of the new instrument's galvanometers. Because no lenses, prisms, or apertures are used, no time-consuming optical adjustments are necessary when replacing lamps.

IMPROVED TIME RECORDER

The new PM-13 oscillograph is equipped with an automatic time recorder which photographically records the time and date of operation on the face of the oscillogram. For station or company identification, a plate may be added to the time mechanism.

UNIT CONSTRUCTION

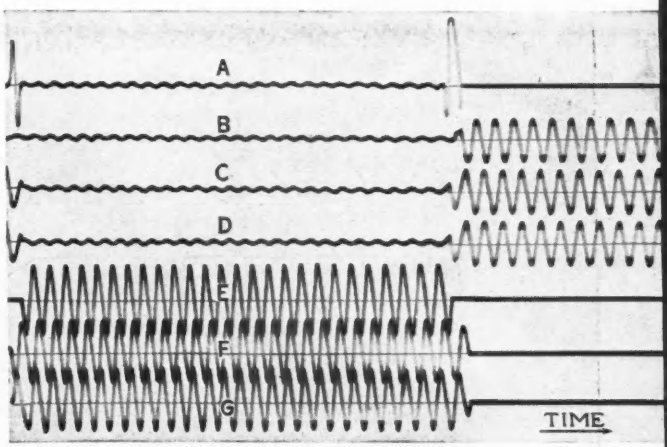
Constructed of simplified unit subassemblies, the front relay panel of the new G-E oscillograph is easier to inspect and maintain.

SIMPLIFIED PAPER HOLDERS

New, light-tight record paper holders mount easily on the top of the oscillograph. Holding up to 200 feet of record paper, the new holders make it possible to obtain as many as 100 oscillograms.

FURTHER INFORMATION

For further information, contact your local G-E Apparatus representative, or write for Bulletin GEC-396 to: Section 605-51, General Electric, Schenectady 5, N. Y.



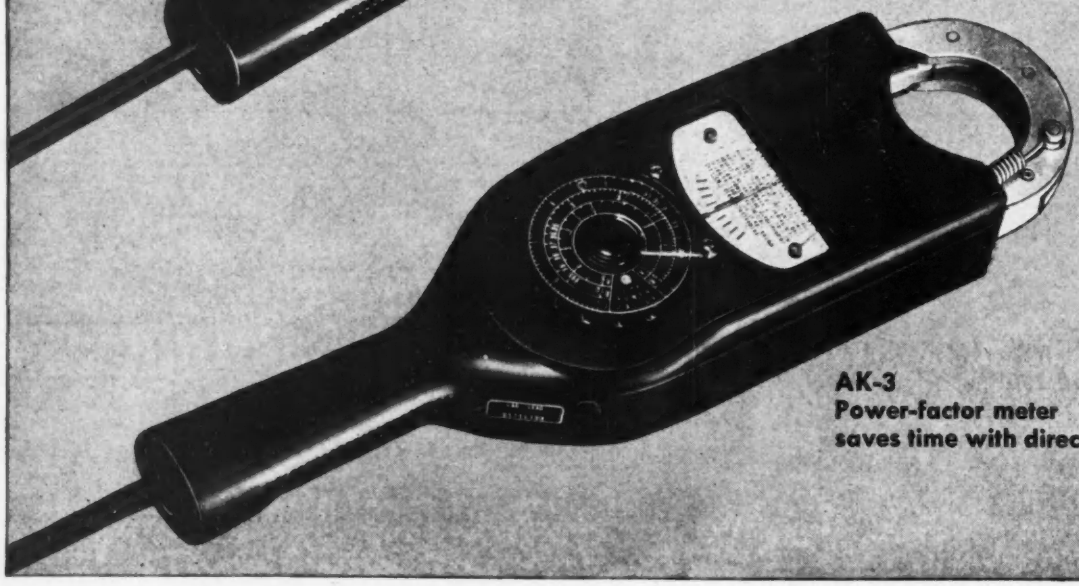
OSCILLOGRAM SHOWS WAVE FORMS of ground current, line current, and phase/phase voltages resulting from lightning fault.

GENERAL ELECTRIC

Speed Electrical Testing with G-E Hook-ons

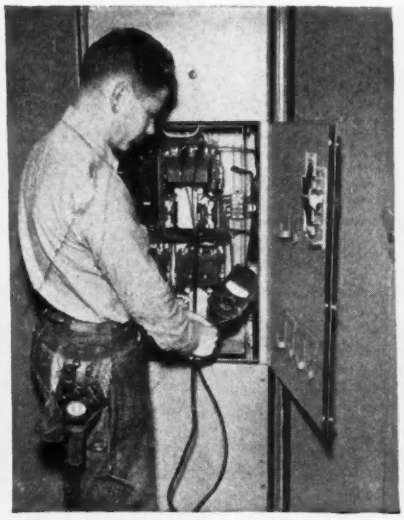
AK-1A
Volt-ammeter provides rapid one-hand operation

AK-2
Wattmeter measures without service interruption

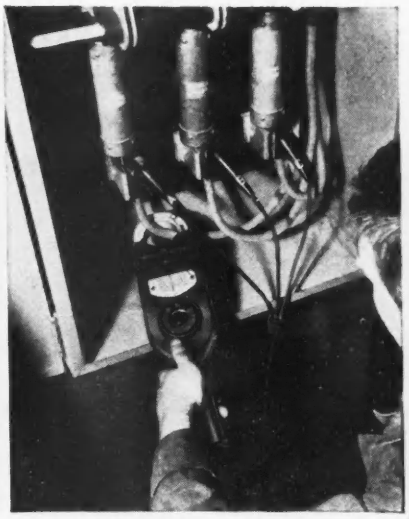


AK-3
Power-factor meter saves time with direct readings

EASY ONE-HAND OPERATION makes this volt-ammeter ideal for line use, as in checking distribution circuits.



SPOTTING OVERLOADS is simple with the compact, lightweight G-E hook-on wattmeter even in many relatively inaccessible places.



DIRECT DIAL-INDICATON is a time-saving feature of the G E power-factor meter, particularly in survey and installation work.

G.E.'s Three Proven Hook-on Instruments Now Immediately Available from Stock

Your order for G-E hook-on instruments can now be filled immediately—to help you at once in reducing today's high electrical maintenance costs by reducing maintenance time.

Since all three of these a-c instruments will work on insulated as well as non-insulated conductors, you do not have to cut conductors when taking measurements. This means you can forget about costly service interruptions and equipment shutdowns.

USERS REDUCE TESTING TIME

The following user comments show how G-E hook-on instruments have demonstrated their value in rapid, low-cost maintenance—

"My AK-1A cuts my electrical testing time in half." (Maintenance Man)

"With my new AK-2 hook-on wattmeter I can do this job in a quarter of the time it formerly took me with conventional instruments." (Plant Superintendent)

"My hook-on power-factor meter alone does the job previously done by using a wattmeter, two current transformers, two ammeters, and a voltmeter." (Engineer)

EIGHT-RANGE VOLT-AMMETER

Eight quickly readable scales (five current ranges and three voltage ranges) make the G-E hook-on volt-ammeter suitable for a wide variety of applications. Use the AK-1A volt-ammeter for measuring load on power and distribution transformers, as well as for load balancing and load surveys on distribution circuits.

VERSATILE HOOK-ON WATTMETER

With the AK-2 hook-on wattmeter you get accurate power readings on either single-phase or polyphase circuits. A few of this instrument's many uses are: checks on switchboard and panel instruments, load surveys, and complaint investigations.

MEASURE POWER FACTOR DIRECTLY

The AK-3 power-factor meter gives you a direct reading, eliminating the time and errors involved in calculations. Designed for use on polyphase circuits, this handy instrument is especially useful for installing capacitors and synchronous condensers.

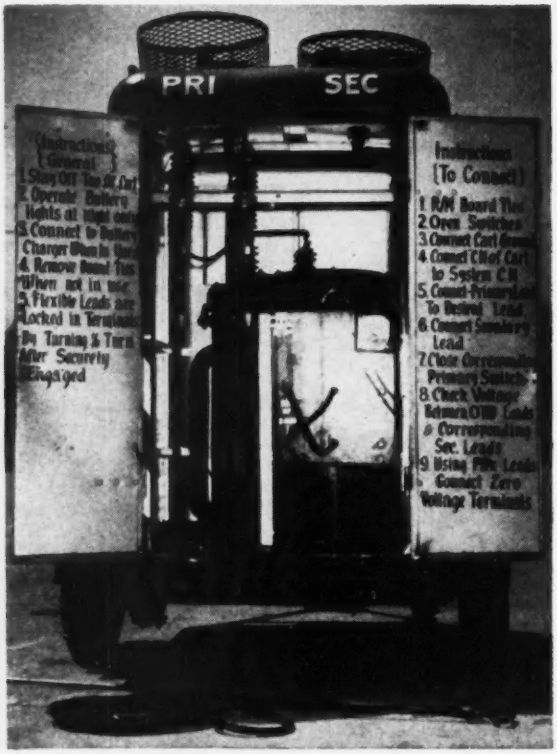
PHONE NOW FOR PROMPT SHIPMENT

To make sure that these accurate instruments are at hand for your immediate testing needs, phone your G-E Apparatus Sales representative today. For further information on G-E hook-on instruments write for GEC-901 to Section 602-270, General Electric, Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

EMERGENCY SERVICE supplied by "Big Mu" eliminates interruptions and cuts outages during transformer replacement or relocation



CONNECTING INSTRUCTIONS shown on rear panel doors of "Little Mu", are kept simple yet complete enough for full understanding

Mobile Transformer Units Reduce Outages 75%

E. F. MAYO, Electric Distribution Div, New Orleans Public Service, Inc, New Orleans, La.

Use of two mobile transformer units by New Orleans Public Service, Inc, has reduced service outage time due to transformer trouble approximately 75%. Nicknamed "Big Mu" and "Little Mu" because of their respective sizes, they were designed and built by members of the Electric Distribution Div of the company.

The units are used principally for preventing outages for customers supplied by transformers which must be replaced or relocated at a scheduled time. Whichever mobile unit is needed is wheeled into place and connections made ready so that only a momentary interruption is necessary.

Before these units went into operation, damage to transformers—especially on Sundays or holidays—sometimes caused lengthy outages because of time required to assemble line crews on the scene.

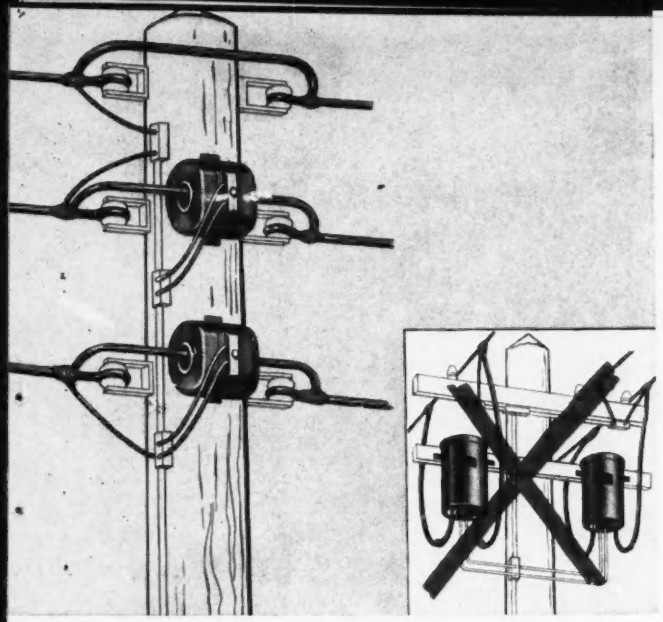
Now, when a transformer call is received, whichever "Mu" is needed is hooked behind a service truck and moved to the scene. The crew of the service truck has only to disconnect the leads of the damaged transformer and substitute those from the mobile unit transformer and service is immediately restored. The mobile transformer unit then continues to provide service until line crews can replace the damaged unit on the next working day.

If it is necessary to perform work on, or remove, a transformer that is still in service, "Little Mu" can easily be connected in parallel with the transformer on the pole, after which the field transformer can be removed. Instructions for making connections are on the inside of the doors to the unit. However, it must be noted that in this instance, backfeed is introduced into the existing transformer until it is disconnected from both the primary and secondary.

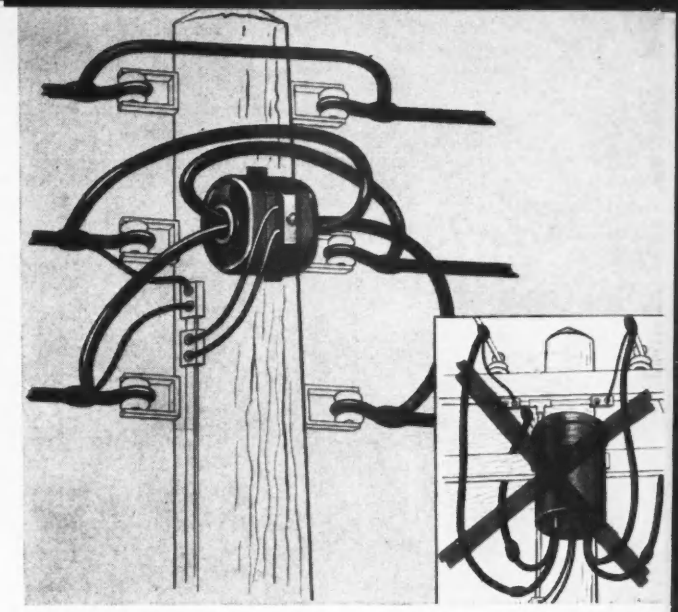
"Little Mu" is equipped with one 50-kva, 7,620-120/240-v transformer and also a 50-kva, 2,400-120/240-v transformer, mounted on a two-wheel trailer chassis. Its operations are confined to single phase. Three-phase work is left for the more complex "Big Mu."

"Big Mu" is equipped with four transformers—two 37½-kva units for use on 7,620-v and two 25-kva units for use on 2,400-v primaries. It is capable of supplying three phase, three-wire; three phase, four-wire delta; single phase (using one transformer); and single phase with two of the four transformers in parallel to increase the available capacity. This unit was designed by the author.

Other utility companies have indicated an interest in duplicating the mobile units. Public Service is presently building an additional unit with two 75-kva transformers for use on single phase 2,400 and 7,620-v primaries.



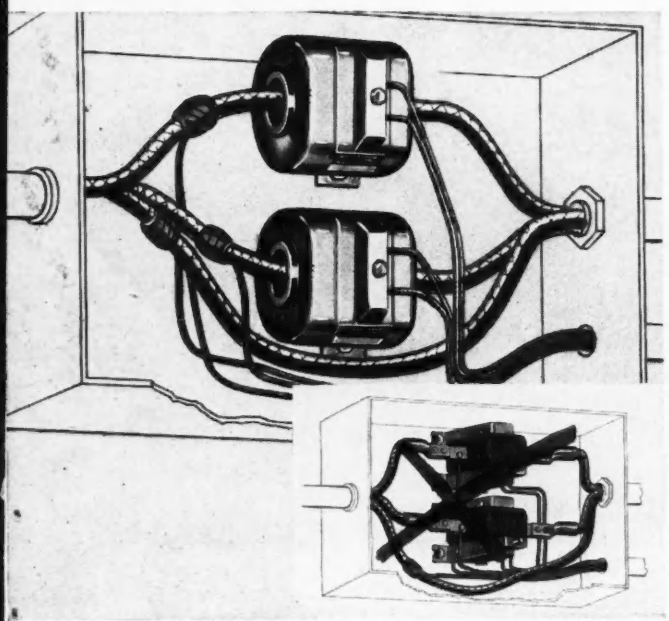
BUTYL-MOLDED, WINDOW DESIGN. Butyl makes the transformer attractive and easy to install; window makes wiring easy. JKP-0 easily replaces standard Type JKB-2.



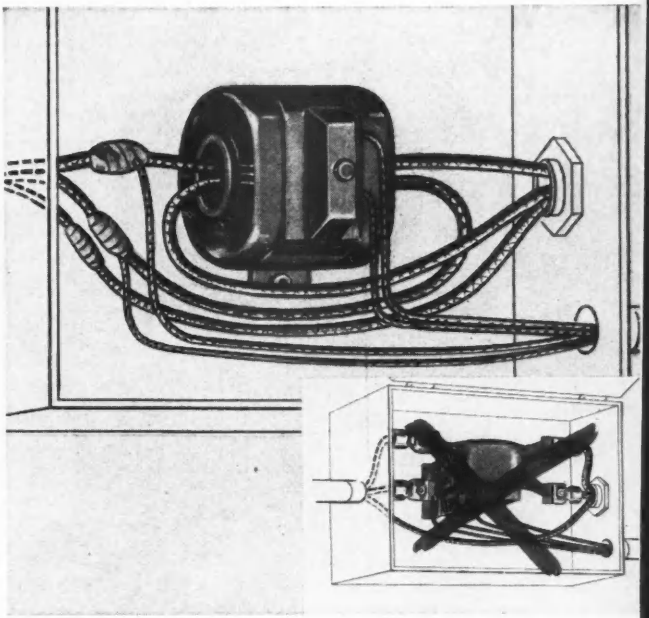
LOWER INSTALLATION COSTS. In replacing some conventional standard transformers (above: JKR-1) the JKP-0 eliminates need for crossarms, hanger connections, etc.

4 in 1

NEW G-E CURRENT TRANSFORMER REPLACES 4 STANDARD MODELS



LOWER MAINTENANCE COSTS. The JKP-0 will not corrode, breakage is reduced, no painting is needed—due to butyl construction. Above: JKP-0 replaces G-E Type JL-1.



INDOOR-OUTDOOR VERSATILITY. Because it replaces many other types, the JKP-0 cuts stock and inventory costs. Here the butyl-molded JKP-0 replaces the Type JKB-1.

(604-16)

Write or call your nearest G-E Apparatus Sales Office, or authorized agent or distributor. Ask for Bulletin GEA-5874. General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

READY TO START moving the 750-kva General Electric network transformer, with submersible protector, from trailer to vault. Notice the room air-conditioning units in the windows—one of the reasons why more capacity is needed here.

Potomac Electric, Washington, D.C., installs G-E network unit to meet extra-heavy load demands

System reinforced with 750-kva G-E transformer and network protector

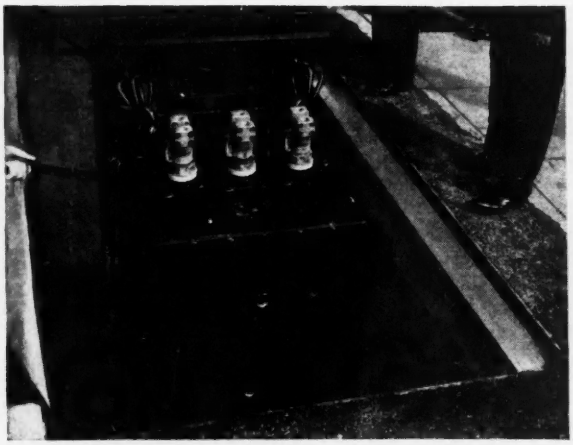
The flexibility and ease of expansion provided by a secondary network system certainly "pays off" for Potomac Electric Power Company in downtown Washington, D. C. Flexibility of the system permits load growth additions with minimum interference to service in the highly concentrated downtown area.

The financial district is experiencing a phenomenal growth and the consequent heavier load requirements, including air-conditioning in existing buildings in the area, necessitated installation of this 750-kva G-E network transformer. The unit, equipped with a submersible automatic network protector, is located at 730—15th Street, N. W., directly in front of the American Security and Trust Company building.

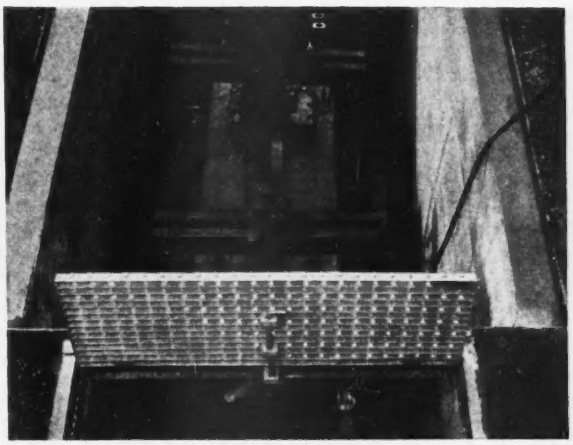
Compactness of G-E network units permits minimum vault depth (7 feet to roof slab) for lower installation cost.

It pays to start a network. Although the change from a radial to a network system means substantial initial expense, future increases in capacity require less investment with a network system. With a growing load, the sooner the network system is started, the lower the ultimate cost. Why not investigate the advantages for your system?

For help in solving your network problems, and for complete information on the many advantages of G-E standardized network units, get in touch with your nearest G-E Apparatus Sales Office, or write for Bulletin GEA-5024, General Electric Company, Section 431-201, Schenectady 5, N. Y.



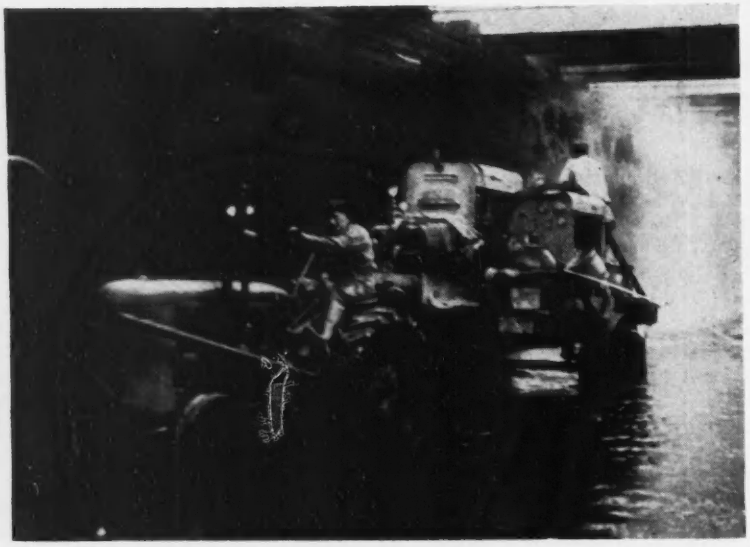
ALMOST IN PLACE and with minimum inconvenience, even in a congested downtown area. Note the G-E submersible automatic network protector on the low-voltage end of the transformer.



CENTERING UNIT in vault prior to cabling. Convenient location of cable terminals on G-E units makes minimum size vaults practical—simplifies connections for fast installation.

You can put your confidence in—

GENERAL ELECTRIC



TURRET NOZZLE is used to direct 275-psi stream of water upon side of wood flume. Cost of removing moss from flume was about $520. Cleaning added 800 kw to plant capacity

Clean Moss from Flume in 13½ Hours

GEORGE K. MERZ, Chemist, Portland General Electric Co, Oregon

Capacity of Portland General Electric Co's Station G increased about 800 kw following removal of moss from a half-mile wood flume by washing with high-pressure water. Cleaning operation took only 13½ hours and cost about $520, including cost of labor and rental of equipment.

Flume at Station G is an open-top type of untreated Douglas Fir, and measures 18 ft wide by 13 ft deep by about 2,500 ft long. It handles water from the Clackamas River which is so clear that moss grows profusely on all underwater surfaces exposed to sunlight. Scouring action of pebbles on bottom of flume helps minimize growth on this surface.

Because of large volume of water handled by the flume and danger of harming fish life in the Clackamas (a game stream), use of chemical added in "slugs" was ruled out until further tests could be made. Unwatering the flume and spraying with a toxic material, such as pentachlorophenol, was considered unsatisfactory because it was felt dead moss would not fall off. Stepped sides of the flume made brushing or scraping impractical. This left hydraulic removal as only practical means, although it was accepted that results would only be temporary.

Equipment comprising the washing rig included two 400-gpm gas-engine-driven centrifugal pumps, one is a 200-psi two-stage unit and the other a 125-psi unit; a standard 2.5-in. turret nozzle with ⅞-in. orifice; and a portable light plant with two 500-w floodlamps. Equipment was mounted on a five-ton, dual-wheel, steel-bed trailer that was pulled by a rubber-tired tractor.

Other material carried on the trailer included two barrels of gasoline, gasoline pump, lubricating oil, fire extinguishers, and spare parts, such as fan belts and carburators. Spare parts were carried because local road repairs eliminated access to the outside during the cleaning operation.

Suction pipe, consisting of a 6-in. pipe 15 ft long with perforations along its underside, was suspended several inches above ground under the trailer. Various equipment were spotted on trailer and angle iron guides welded to bed around them. Thus, equipment could be removed or replaced easily and quickly. Turret nozzle was mounted at rear of trailer and connected through a flexible adapter to pumps in series. After set-up was tested in-place, equipment was removed and trucked to head of the flume.

After the tractor and trailer were placed in flume with a mobile crane, equipment was spotted on trailer bed and all connections were made. Flume head gates were left open sufficiently to allow about 1½ ft of water to flow in flume. This provided a continuous supply of clean water for washing.

Washing rig, manned by tractor driver, mechanic and two nozzle operators, moved upstream and washed downstream so that loose moss was carried away from suction pipe. With nozzle pressure of 275 psi at 300 gpm, one wall was washed at a time to insure best removal of moss.

Work continued after dark under the floodlamps. Only difficulty, other than minor equipment failures, was a small fire due to leaking gasoline that was quickly put out.

Progressive Oil Purification Saves Clay and Cuts Costs

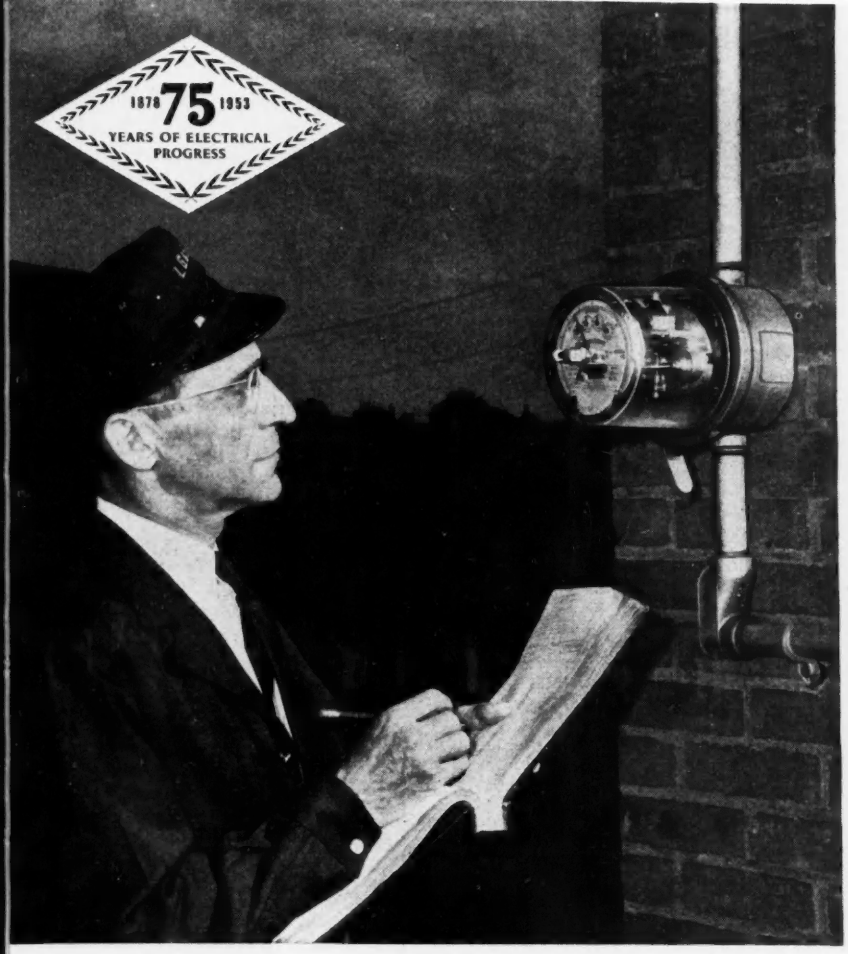
A. M. McCABE, Formerly,* Substation & Val. Supt, Carolina Power & Light Co, Raleigh, N. C.

A recent rearrangement in the insulating oil purifying equipment at Carolina Power & Light Co, not only saves considerable clay, but cuts cost of reclaimed oil from 12.71¢ per gal to 4.99¢ per gal compared with formerly used arrangement. The new method arrangement has a capacity of about 1,000 gal per day.

A previous article by Mr. McCabe (December 15, 1952 issue of Electrical World, page 130 and 132) described the new method of handling clay which reduced clay handling costs from 2.47 to 0.60¢ per gallon (see schedule of costs).

Progressive Purification . . . To save clay, the method of progressive purification through a number of tanks was adopted. In this manner, fresh clay is used on almost "good" oil, and finally on "bad" oil, thus utilizing the

* A. M. McCabe is now deceased.



IM-50 Meters Give Accurate, Low-Cost Demand Measurement

Moderate price and low installation cost make the General Electric IM-50 watthour demand meter the type best suited for measuring demand of small industrial and commercial power users.

The watthour meter is the well-known Type I-50, having such benefits as magnetic suspension (no meter-bearing wear), lightning protection, and sustained calibration—which combine to give accurate and reliable performance with little maintenance. The demand register is a mechanical block-interval type—either indicating (M-30) or cumulative (M-31).

QUICK, EASY RESETTING—The reset mechanism is simple and readily resealed, requires only one hole in the glass cover, and is corrosion-resistant to prevent sticking with rust.

Interval resetting is positive and precise, with no impact upon returning to zero. This minimizes wear and the possible necessity for occasional readjustment.

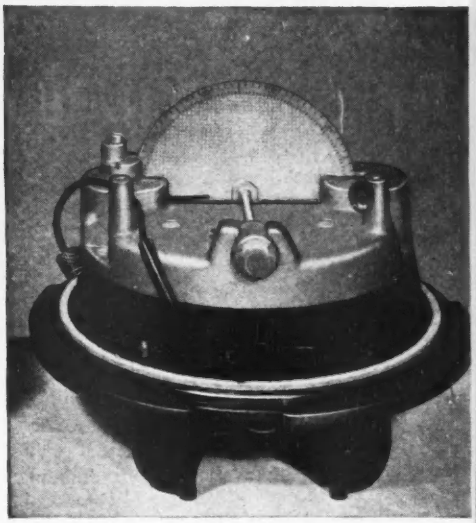
ADJUSTMENTS MINIMIZED—The register has few adjustments, all accessible and easy to make. Freedom from wear, together with high factors of safety, reduces any subsequent readjustment to the minimum.

For more information, contact your G-E representative or write Section 601-93, General Electric, Schenectady 5, N. Y.

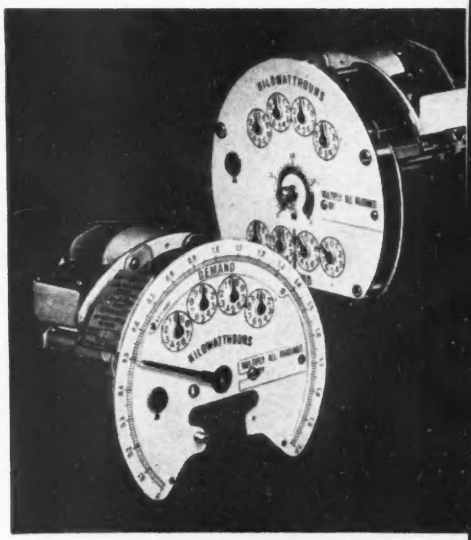
You can put your confidence in—

GENERAL ELECTRIC

IM-50 METERS are available for socket (left) or front (above) connections, with variations up to 10% of rated meter voltage permissible.



I-50 FEATURES such as magnetic suspension, die-cast frame, and molded insulation provide sustained accuracy and reliable performance.



INDICATING OR CUMULATIVE REGISTER is used. Either can be purchased separately for use on watthour meters that are now in service.

PURIFICATION TANKS (three at right of center) are old transformer tanks. Original tanks were extended to obtain desired volume of 1000 gal. Only two pipes extend to purifier room. Float switches actuate signal when purification tanks are empty

clay to its maximum cleansing ability. Three old transformer tanks of 1,000-gal capacity, called No. 1, No. 2, and No. 3 below, were set up near "bad" and "purified" oil storage tanks and fitted with suitable valves and piping.

When transformer repair crew begins work at 8:30 a.m., one man dumps clay that has been draining since the previous morning and refills baskets with fresh clay. Another man removes used clay baskets from purifiers, hangs these up to drain, puts fresh clay baskets in the purifiers, sets valves to pass oil from No. 3 tank through the purifier into the "purified" oil tank, and starts the heaters and pump. This requires about 1 hr, and these men then join the rest of the repair crew on other work.

About 11:00 a.m. tank No. 3 is empty, and one man leaves his transformer work for 5 min to change valves and thus transfer oil from No. 2 to No. 3 tanks through the purifier; about 1:00 p.m. from No. 1 to No. 2; about 3:00 p.m. from the "bad" oil tank to No. 1; and about 5:00 p.m. he picks up the drained oil from the drip pan with the purifier and puts the purifier to circulating on the "bad" oil tank. The purifier continues to run after the crew leaves, and a time clock shuts it off at 2:00 a.m., which is about the time clay becomes ineffective.

The company is considering the possibility of using fewer passes between "bad" and "purified" tanks when oil condition permits.

Plant at shop . . . When purifiers were first obtained, it was thought they would be used mostly at outlying stations, and that later a large purifying plant would be built at the shop, if purification appeared worth while. We are now convinced that purification, plus inhibitor, is desirable, but with the above arrangement 1,000 gal of oil can be purified a day, which will be ample for the system for many years. With lower costs in the shop than in the field, and ease with which oil can be hauled compared with hauling the purifying equipment and clay, we do not expect to purify oil at stations away from our shop, except in occasional special cases.

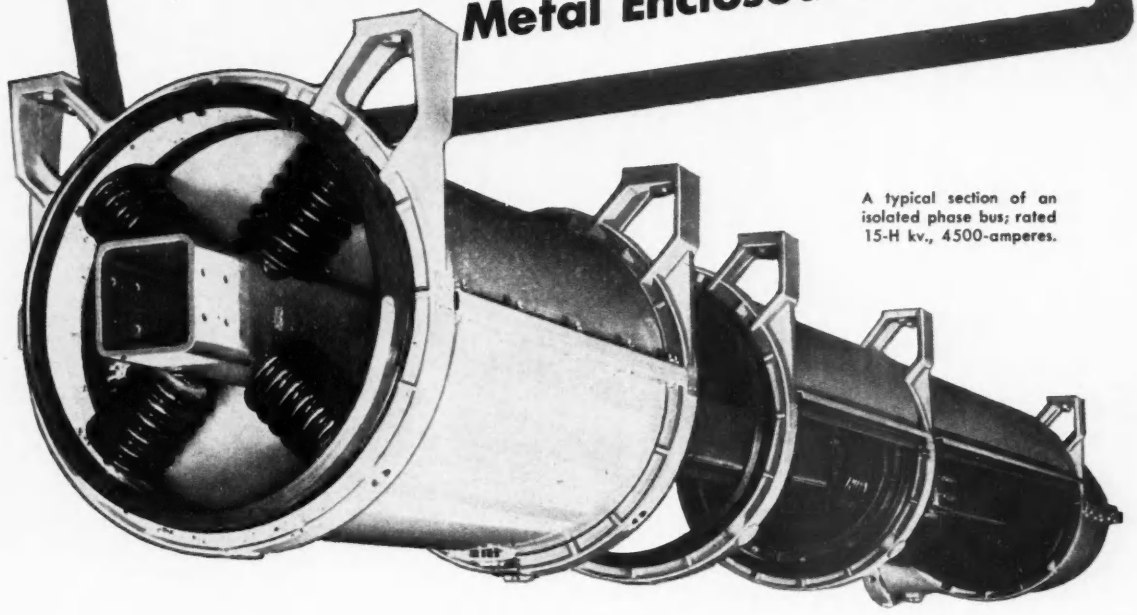
Transporting oil is accomplished with a tank trailer that can be pulled with a tractor. In addition to hauling oil, the tank trailer can be parked at stations where transformer and breaker changes are being made, thus eliminating the need for permanently installed oil storage tanks at most future stations.

Cost of Reclaiming Transformer Oil

(Equipment and Overhead Costs Excluded)

Item	Before Rearrangement: 9,490 gal initial—8,200 gal final. N/N from 0.44 to 0.04. IFT from 16.8 to 35. (Circulating on one tank.)		After Rearrangement: 8,570 gal initial—8,100 gal final. N/N from 0.67 to 0.08. IFT from 14 to 34. (Passing through intermediate tanks.)	
Cranite at $.0413/lb	30–250 lb charges—7500 lb	$309.75	18–250 lb charges—4500 lb	$185.85
Unloading cranite	12 man hr for 9000 lb—7500 lb	15.85	4 man hr for 9000 lb—4500 lb	3.15
Cranite storage to purifier	16 man hr 7500 lb	25.35		0.00
Cranite disposal	36 man hr 7500 lb	57.08	7.2 hr Janitor 4500 lb	7.51
Filling & emptying bags	33 man hr (15 changes)	52.30	13.5 man hr (9 changes)	21.39
Changing bags & felts	33 man hr (15 changes)	52.30	4.5 man hr (3 changes)	7.13
Operating valves		0.00	6 man hr (36 times)	9.52
Bags	30 at $2.69	80 70	6 at $2.69	16.14
Felts	30 at $2.07	62.10	6 at $2.07	12.42
Subtotal		$655.43		$263.11
Oil lost	1290 gal at 30¢	387.00	470 gal at 30¢	141.00
Total		**1,042.43**		**404.11**
Total cost per gal reclaimed		**12.72**		**4.99**
Cost per gal—clay handling only		**2.47**		**0.60**

A DIRECT PATH TO BETTER PROTECTION with DELTA-STAR Isolated Phase Metal Enclosed Bus Runs



A typical section of an isolated phase bus; rated 15-H kv., 4500-amperes.

DELTA-STAR METAL ENCLOSED BUSES ARE AVAILABLE FOR ALL REQUIREMENTS

"Unit-type" metal-enclosed bus designs are available in a wide variety for isolated phase, segregated phase and non-segregated phase construction. Delta-Star's experienced engineers will make an analysis of your proposed installation and determine which type will be the most economical for your service requirements. Regardless of the type selected, you are assured of a design which will fit into your installation at lowest possible erection cost.

For complete information ask for Publication 5006.

Here is the safest direct path between generator and station bus or transformer. Absolute isolation of each phase eliminates the possibility of a phase to phase fault.

Phases individually isolated and enclosed. Bus is supported within heat treated cast aluminum rings by porcelain insulators which are always placed in compression both under normal load and in event of short circuit.

Aluminum Covers in identical halves with silvered channel shape edges provide strong sections for bolting and good electrical contact between halves. Specially shaped neoprene gaskets eliminate dust and moisture. Large area ring gaskets permit liberal misalignment of ducts without reducing seal. Covers easily removed for inspection.

Easy to Erect — Simple to Install. Every structure is custom built to meet specific requirements, factory engineered, factory assembled and factory tested before shipment thus reducing installation cost to a minimum.

FOR COMPLETE DETAILS write or call our nearest district representative or our main office.

WHEN YOU WANT THE BEST IN HIGH VOLTAGE SWITCHING EQUIPMENT SPECIFY DELTA-STAR

DELTA-STAR ELECTRIC DIVISION

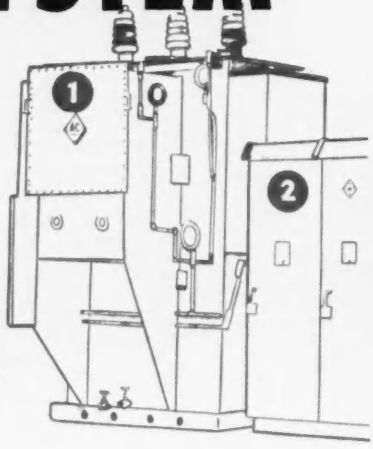
H. K. PORTER COMPANY, INC.
2437 FULTON STREET, CHICAGO 12, ILLINOIS
DISTRICT OFFICES IN PRINCIPAL CITIES

ALLIS-CHALMERS

MULTI-CIRCUIT

Unit Substations

GROW WITH YOUR DISTRIBUTION SYSTEM



① By Double Ending
② Adding Feeders
③ Increasing Transformer Size

Here's How Allis-Chalmers Substation Design Eases Future System Growth Problems

YOU CAN PREDICT your entire system load at some future date easier than you can predict that of a specific substation. A new housing development, a new industry, a new shopping center—each can make a major change in the load on one substation without greatly affecting the entire system. That's why substation design must be *flexible!*

Easy Field Assembly Speeds Expansion

Allis-Chalmers unit substations not only meet your immediate needs, but are designed to grow with the areas into which they are installed. They are designed for easy addition of feeders . . . easy double ending . . . and easy application of larger capacity transformers.

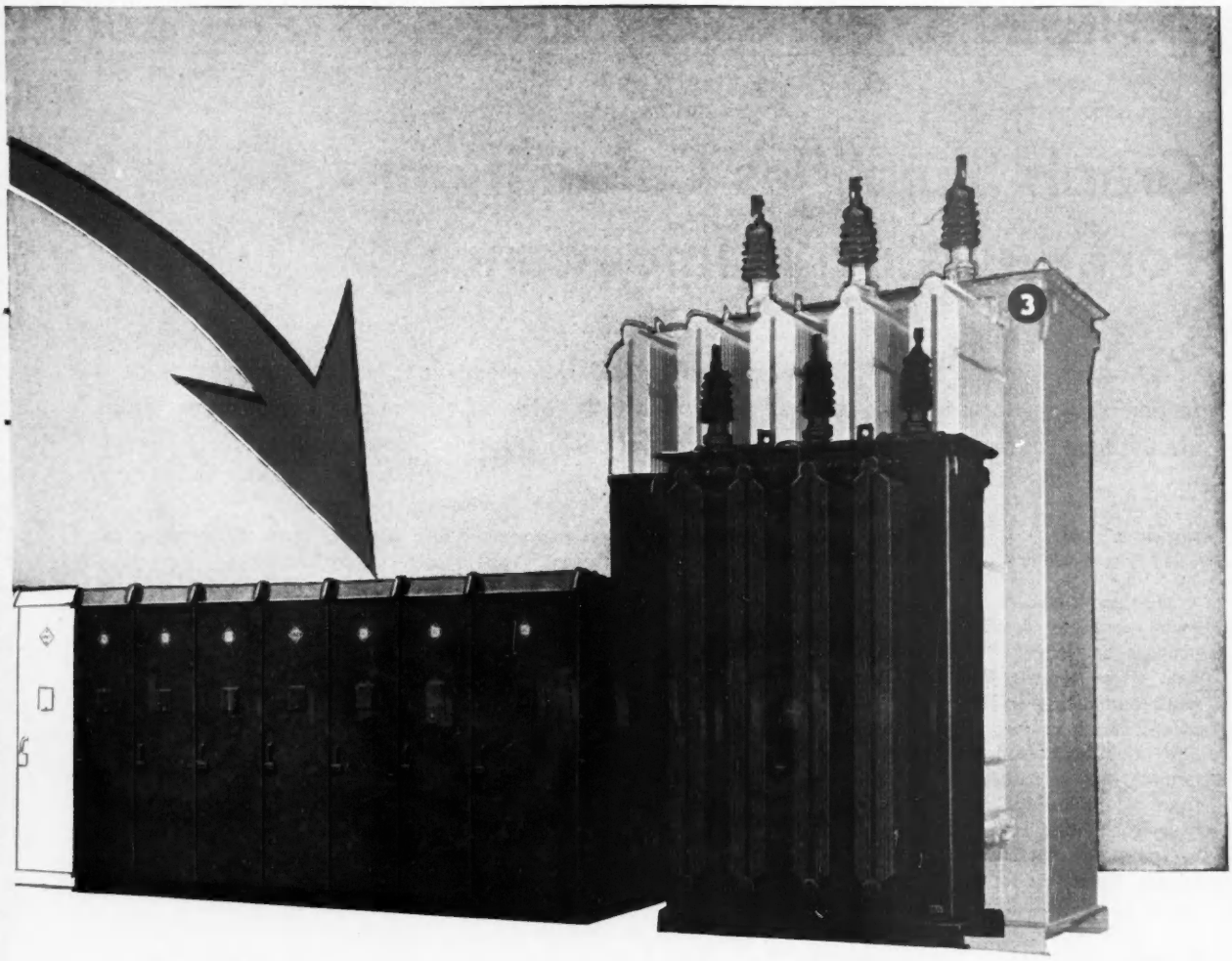
Allis-Chalmers Unit Substations are a convenient answer to the growing distribution problem . . . to the ever increasing demand for power and yet more power. They are simple to specify, neat and modern in appearance, and easy to expand.

You Save These Five Ways

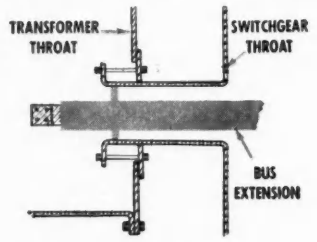
(1) Original equipment cost is low; (2) compact construction reduces space requirements and real estate costs; (3) pre-wired unit design speeds installation; (4) maintenance is quick and economical because of improved accessibility; and (5) you purchase only the equipment you need *now*, deferring additional expenses until load growth demands the expenditure.

For the full story on what Allis-Chalmers Unit Substations can mean in your distribution system, call your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3585

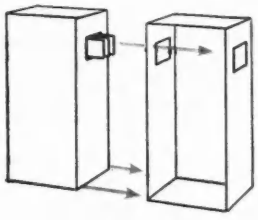
ALLIS-



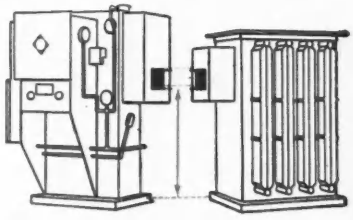
MCS Substations are Expandable These 3 Ways



1 **DOUBLE ENDING** is easy. Throat openings of transformer and switchgear are at exactly the same height. Bus connectors and transformer throat are flexible enough to permit realistic tolerances in concrete base construction. Silver-plated, pre-drilled bus extensions bolt together, are tape covered to speed field assembly.



2 **FEEDER UNITS** are easy to add because they are jig built. Each feeder cubicle is exactly like every other one. Bus extension openings, control wiring openings — even small screw holes — are pre-cut in jigs for perfect alignment. This uniform construction, plus two sides on every cubicle, makes field assembly easy.



3 **A HIGHER CAPACITY TRANSFORMER** — within the limits of breaker size and bus capacity — can easily replace the installed transformer. Standardized throat height on all A-C substation transformers, regardless of rating, permits one transformer to replace another without cutting or reforming the throat or bus.

CHALMERS

A-C ALLIS-CHALMERS

Graph Simplifies Calculations For 5-kv Circuit Impedance

Accompanying graph has been designed to find the impedances for various lengths of a feeder from feeder origin to taps and to eliminate the otherwise numerous calculations. Steps are outlined for preparing graphs on other types of cable and other voltages

FRANK E REEVES,* Electrical Engineer, Los Angeles, California

The graph shown will serve in many cases to determine the impedance of feeders. This method is time saving because distribution systems, particularly in large industrial plants, can have feeders with many taps to multiple loads. And to determine the interrupting duties of fuses and circuit breakers at each tap, many calculations are necessary.

Graphs for other types of conductors or cables and for other voltages can be readily prepared.

Preparation of Graphs . . . When standard cross-section paper is used, only one calculation is necessary for each size of conductor and feeder voltage. The reason—impedance is directly proportional to conductor length.

Values of conductor resistance and reactance for one mile or for 1,000 ft can be obtained from tables in handbooks. Values for 3-conductor belted cables are used customarily if no tables are available for three single-conductor cables in the same duct. Due to the approximate nature of fault calculations in general, the error resulting will be probably within the precision of the calculations.

Formulas to be used are:

$$Z = \sqrt{R^2 + X^2}$$

where Z is the impedance of the conductor, R is ac resistance of the conductor, X is positive phase sequence reactance, and all values are for one mile or 1,000 ft.

$$\%Z = \frac{\text{Base KVA} \times Z}{(\text{KV})^2 \times 10}$$

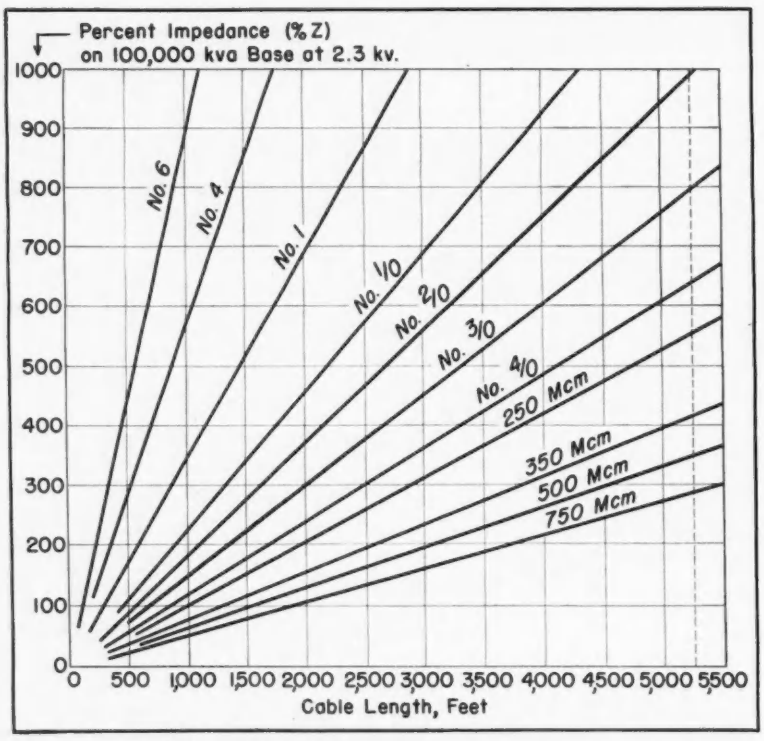
where KV is line-to-line voltage on the feeder. (For the chart shown, the base kva is 100,000 and kv is 2.3.)

The value of Z is plotted on the graph paper for 5,280 ft or 1,000 ft depending on the values obtained from the handbook. Then a straight line is drawn from that point to the origin of coordinates.

Short-circuit kva may be determined by finding the %Z for the required cable length from the graph and applying it in the formula:

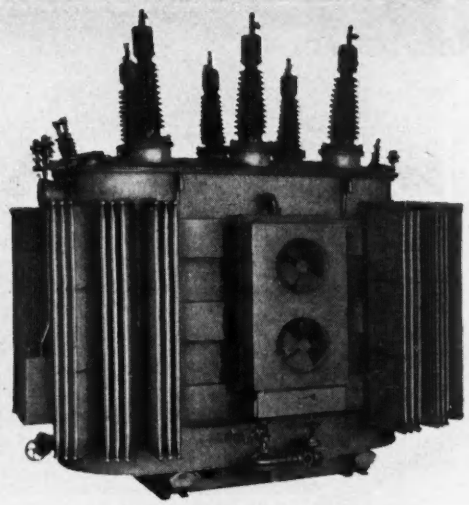
$$\text{KVA}_{sc} = \frac{\text{Base KVA} \times 1000}{\%Z \text{ of origin} + \%Z \text{ of feeder}}$$

Selection of a base KVA is usually an even power of ten, for simplification of calculations.

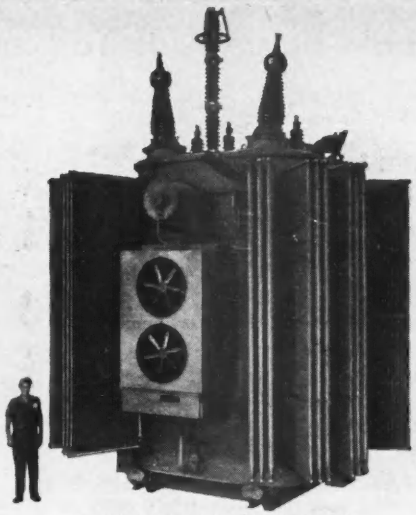


PERCENT IMPEDANCE, on 100,000-kva base at 2.3 kv, in relation to cable length is given for 3-conductor belted cable or three single-conductor unshielded cables (0-5 kv) in same duct. In this graph conductor sizes range from No. 6 to 750,000 cir mil

*Book publication rights reserved by author

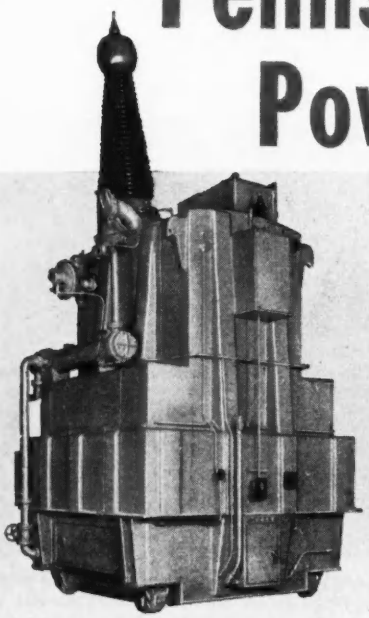


36,000/48,000/60,000 KVA
Auto Transformer. Three-phase, 60 Cycles, 55°C. Rise. 138,000 Grd. Y —115,000 Grd. Y—13,800△ volts.



25,000/33,333/41,667 KVA
Single-phase, 60 Cycles, 55°C. Rise. 110,000—7950/13,800 volts.

Pennsylvania Oil-filled Power Transformers



29,000 KVA
Single-phase, 60 Cycles, 55°C. Rise. 230,000 Grd. Y/132,800 —13,200 volts.

According to NEMA Standards, oil-filled transformers can be cooled in nine different ways. The manner of cooling depends upon many considerations, such as the operating characteristics of transformers using various types of cooling; the availability of large quantities of water; and what is very important, the economics of selecting one type of transformer over another.

The latter consideration may require some study. Auxiliary cooling methods applied to a self-cooled transformer can add, at relatively low cost, as much as 66⅔% additional capacity to the transformer. On the other hand, the efficiency of the transformer and the cost of operating certain types of cooling equipment may be more important considerations than the initial lower cost of a forced-cooled transformer. These are matters that can best be discussed between the engineers who specify a transformer and the engineers who design the transformer.

Pennsylvania Transformer Company manufactures transformers of every standard classification and with every type of cooling equipment. If you have a problem in cooling, or for that matter, if you have any transformer problem, you are invited to utilize the experience of Pennsylvania's Engineering Department.

Write for free copy of booklet No. 522 entitled "Economics of Transformer Cooling." This booklet explains the various methods of cooling transformers and discusses their advantages and disadvantages.

PENNSYLVANIA TRANSFORMER COMPANY
A McGRAW ELECTRIC COMPANY DIVISION
CANONSBURG, PA. • *Greater Pittsburgh District*

Portable Boom Aids Turbine Maintenance

CLARENCE D. McCARTHY, Hydro Maintenance Mechanic, Appalachian Electric Power Co, Lynchburg, Va.

Use of a portable boom has facilitated removal of generator-shaft, guide-bearing sections, which weigh several hundred pounds, at Appalachian Electric Power Co's Reusens hydroelectric plant. Boom provides convenient suspension point for rope blocks or chain hoists, which was previously difficult to find.

Other features of the boom include: Three part construction to facilitate rapid assembly or disassembly, a 4-wheel trolley electric hoist providing radial motion, and simple design of generator shaft attachments that permits circular motion.

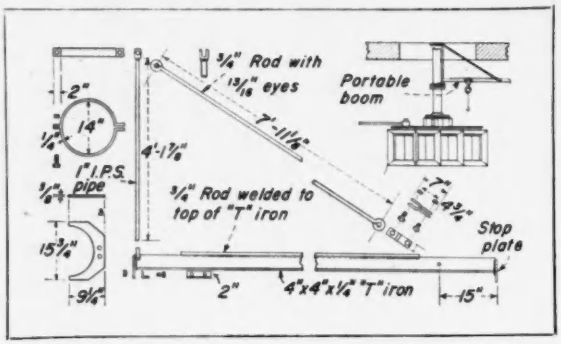
Since the portable boom was constructed, it has been found useful for other purposes, including the following:

1. Removing gate-rod bolts which may stick in the wicket gates due to accumulation of rust and scale along their length.

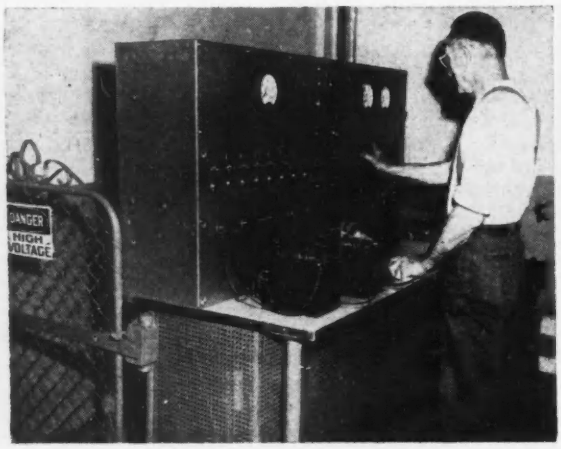
2. Removing wicket gates, formerly difficult due to the problem of suspending a hoist so it would be over the turbine edge and also movable around its circumference.

3. Aiding shaft-alignment checks, formerly hampered by cluttered-up working space and stumbling hazard created by hoist rigging. Previously, bearing parts had to be moved the minimum distance away from the shaft to give rigging clearance. Now, the bearing components are easily lowered to the turbine pit floor so that alignment checks can be made safely and speedily.

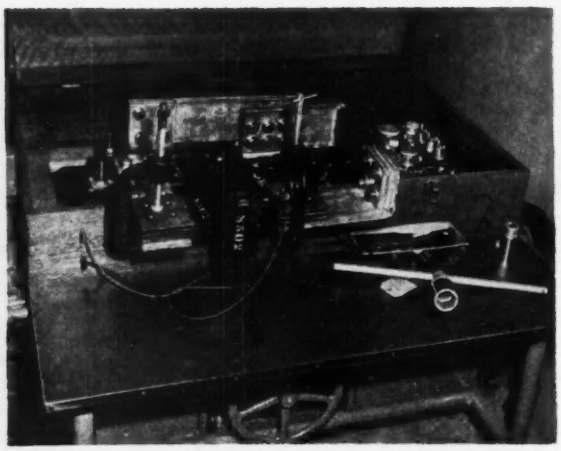
Time spent in constructing the portable boom was soon offset by time saved in maintenance operations. A considerable saving in the cost of constructing the boom was made by using scrap material available at the plant.



COMPONENT PARTS for boom which has simplified maintenance. Assembled boom is shown in upper left



ROTATING STANDARDS are used to compare output of transformer under test with standard on test bench. New unit handles current transformers up to 4,000 amp and potential transformers up to 13 kv



HIGH-CAPACITY STANDARD to which current transformer under test is clamped is positioned in two movements. Lift operated by wheel below table raises it until it may be rolled to proper spot

New Bench Speeds Instrument Transformer Testing

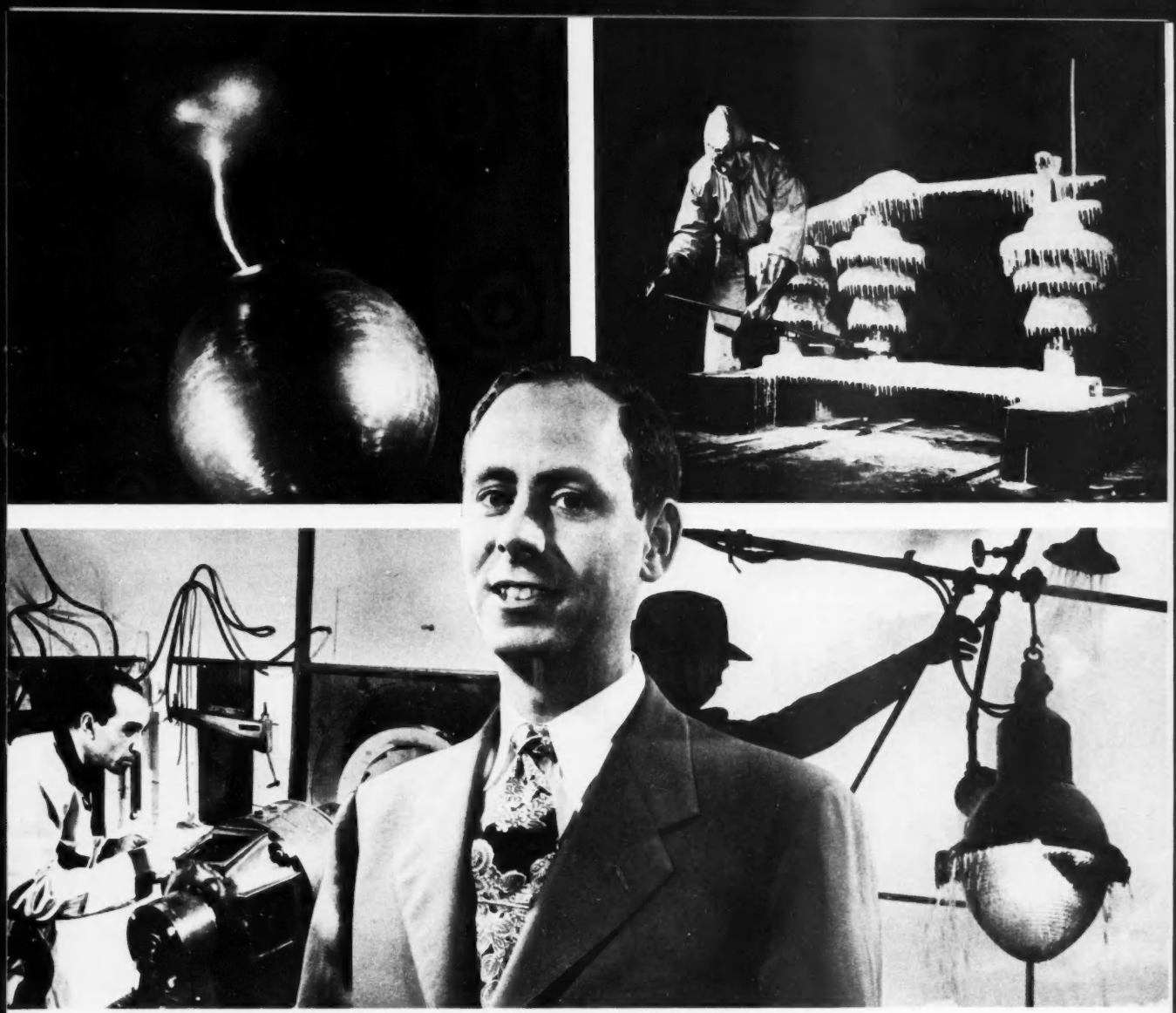
J. T. LANG, Asst Supt of Electric Meter Department, Public Service Co of Colorado, Denver

Safer, more convenient, and faster testing of instrument transformers is provided in a new test installation designed and built by Electric Meter Dept of Public Service Co of Colorado. Current transformers up to 4,000 amp and potential transformers up to 13 kv may be tested.

Installation consists of two main components—test bench and loading transformer box. Mounted on front of bench are meters for reading voltage, current and power, toggle and tap switches, binding posts and indicating lights. Rotating standards are used for comparing unit under test with standard.

Eight toggle switches at left of bench, including one spare, cut in standard potential transformers, lo-

(*Continued on page* 175)



Meet R. F. Lawrence*

Westinghouse Electric Utility Engineer.
On the following pages he and five colleagues show what Westinghouse is doing to help you in . . .

Fighting the battle with the elements

*Bob Lawrence works with utilities in the Southwestern area. He acts as liaison between our district and headquarters' engineers. Along with his broad utility experience, Bob has done considerable work in adapting equipment to specific atmospheric problems —salt air, dusty atmospheres and high ambient temperatures.

"Saul Bennon of the Transformer Division points out why . . ."*

Maximum surge strength is inherent in form-fit design

These broad-surface-area pancake coils are the key to the inherently better voltage distribution and surge strength of the Westinghouse Form-Fit Design.

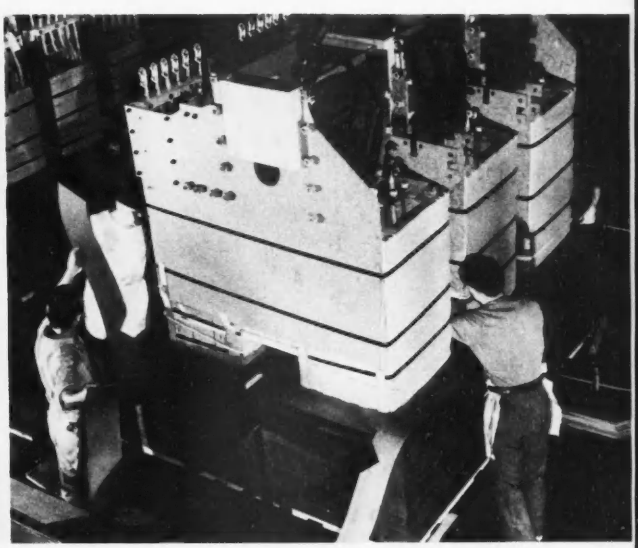
Through the use of relatively few of these broad coils, a high coil-to-coil and low coil-to-ground capacitance is achieved. This capacitance ratio tends to equalize initial voltage drops between all coils of the winding. Thus, voltage does not pile up at the line end and all portions of the winding are equally stressed. The similarity between initial and final voltage distributions also drastically reduces internal winding oscillations and insulation stresses.

The vertical positioning of the coils facilitates the use of interleaved box-type insulation without disturbing the natural flow of the cooling oil. This technique of placing solid insulation along equipotential planes is based upon the knowledge that insulation is stronger in puncture than creep. While this simplified insulation structure materially increases impulse strength, it also permits substantial size and weight reductions.

These and other design features are the underlying reasons why the Westinghouse Form-Fit Design will serve you better under all operating conditions. For further information, contact your local Westinghouse representative or write for Booklet B-4142-A.

J-70704

Building the box-type insulation of a coil group. This technique increases impulse strength while materially reducing size and weight of transformer.



Stacking the supporting and protecting "Hipersil®" core around the coil groups of a three-phase Westinghouse Form-Fit Power Transformer.

Section Manager, Power Transformer Engineering

YOU CAN BE **SURE**...IF IT'S

Westinghouse

"Bob Bobo, Manager, Switchgear Assemblies, presents some timely information on an important protection problem . . ."

Integrally mounted arresters provide surge protection for metal-clad switchgear

Westinghouse has made comprehensive studies in recent years, the results of which can be very helpful in protecting your metal-clad switchgear against lightning surges.

These studies show that switchgear, when cable-connected to exposed lines, may be stressed beyond its basic insulation level, due to traveling wave reflection phenomena. Lightning arresters provide the proper protection for the equipment and, to be most effective, should be located at the switchgear end of the cable.

For these applications, Westinghouse provides cell-mounted arresters of the type shown. These have high surge capacity and are properly coordinated to reliably protect the equipment insulation.

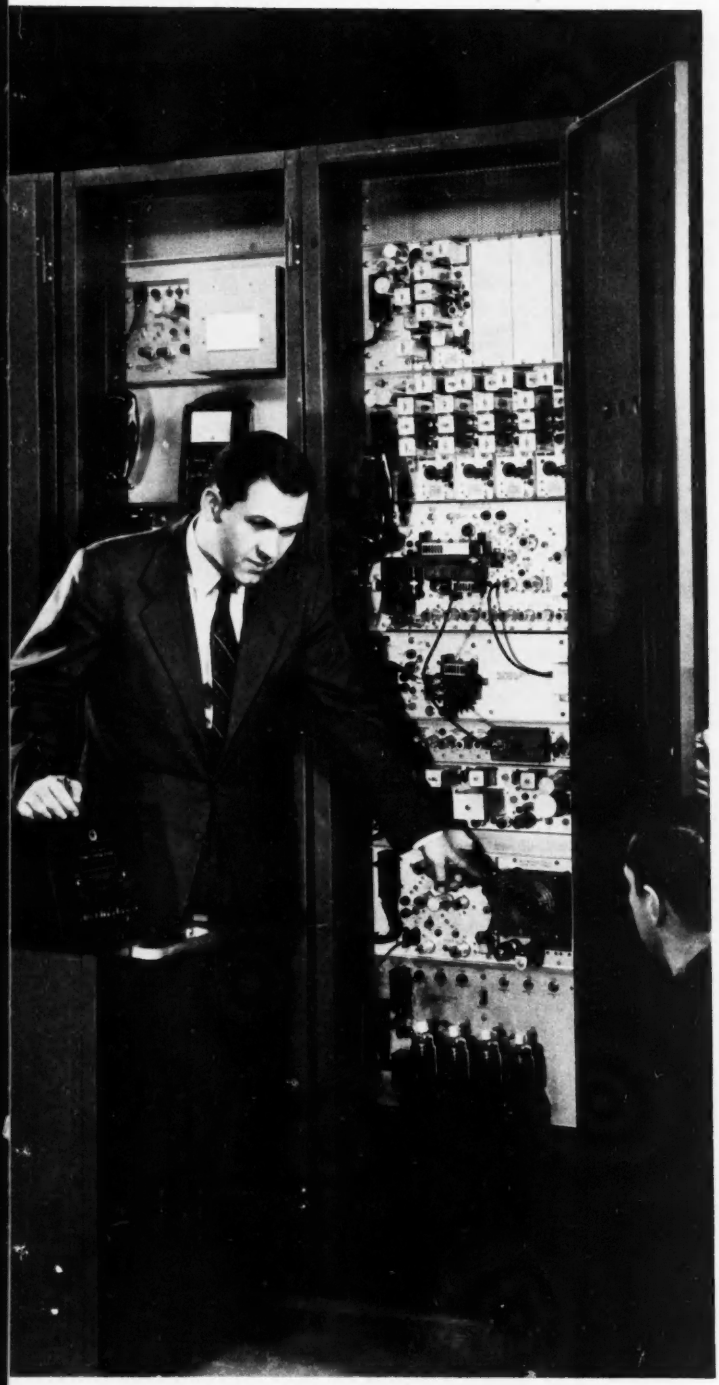
The lightning arresters are tied directly to the line side of the circuit by means of flexible cables. The base provides the ground terminal and a direct path to ground is provided through the arrester base to the ground bus. As you can see here, the lightning arresters are integrally mounted and complete compartmentation is obtained by means of isolating steel barriers. These barriers are easily removed for quick inspection.

Although the assembly shown is typical of outdoor installations, similar applications can be made for indoor metal-clad switchgear.

Contact your nearby Westinghouse representative for detailed application information on this important protective equipment. J-60846

YOU CAN BE **SURE**...IF IT'S

"Nelson Tharp tells you how this microwave communications and control system maintains its high service level during adverse weather . . ."*



This microwave equipment offers stormproof communications

Here's an important development incorporated into the Westinghouse 2000 MC microwave that helps assure reliable communications in all kinds of weather. It's a carefully engineered alarm system that locates and identifies off-normal conditions at any station along the microwave system.

This alarm system reports up to six different off-normal conditions from as many as 31 stations. These are visually indicated by the Remote Alarm Indicator. An audible signal also informs the dispatcher that an irregularity has been registered.

The alarm channel is independent of the 30 voice or 450 telegraphic channels that can be supplied by Westinghouse 2000 MC microwave.

Voice, supervisory control, telemetering, relaying and the many other functions performed over these channels are safeguarded also by the fundamental design. For example: Unit construction with power supply included, and channel frequencies controlled by crystals, combined with frequency-division multiplexing, produce a strict channel independence that means maximum communications reliability.

Westinghouse has had years of experience in the design and manufacture of microwave, power line carrier and end-use equipment and will recommend communications and control equipment impartially. Call your Westinghouse representative or write for booklet B-5850. Westinghouse Electric Corp., Carrier-Microwave Section, 2519 Wilkens Ave., Baltimore 3, Md.

**Microwave Engineering Manager, Electronics Division*

Westinghouse

"Here is Jack Nelson, Meter Application Engineering Manager, to show you how Westinghouse meters are protected from the elements."

How we protect meters from the elements at five danger spots

From sixty-five years' experience building watthour meters, we know which components are the danger spots most susceptible to damage from the elements. Research engineering has concentrated on these danger spots and one by one they have been eliminated. Here is how we did it:

Registers—gold plating is used to provide a positive protective barrier against corrosion for the precision-milled gears and shafts. Friction and wear have been reduced to a minimum in the register by using involute-shaped teeth which have a rolling motion and not a sliding, scraping action.

Current Coils—now insulated with a new material which increased their insulation level three times. This special polyvinyl resin resists corrosive atmospheres and extremes of heat, cold and moisture.

Potential Coils—are completely enclosed and vacuum-impregnated with Laminac, a special polyester resin of extremely high insulating quality. The result—a coil highly resistant to lightning surge voltages, weathering, and faults between windings and to ground.

Laminations—are Bonderized after forming, for positive elimination of corrosion.

Bases—besides being Bonderized, are zinc plated and then given two coats of lacquer to completely protect them against all types of atmospheres.

For more information on how Westinghouse can help you lick your watthour meter battle with the elements, write for a copy of "What It Takes for Long-Time, Low-Cost Metering", Booklet B-4665-A.

J-40453

YOU CAN BE **SURE**...IF IT'S

"Jim Ford of the Transformer Division explains an important 'all-weather' feature . . ."*

Here's proof that this transformer finish lasts twice as long

One of the continuing projects at Westinghouse for the past several years has been the perfection of a transformer finish that would have double the life of standard paints . . . under any weather or atmospheric conditions.

The result, known as "Coastal Finish", is now being used on all Westinghouse pole-type distribution transformers. That this patented three-coat finish is resistant to all weather and atmospheric conditions is proved by several severe laboratory tests as well as actual field installations under the most severe coastal, industrial and desert conditions.

For instance, the Weather-O-Meter test (bottom illustration) exposes paint panels to periodic cycles of one hour in fog and three hours under ultra-violet light. Two weeks' exposure to this test is equivalent to one year of actual field exposure. Another such test is the salt spray test (results shown in top illustration) in which transformers are subjected to 1000 hours of continuous 15 lb. pressure spray containing a saturated salt solution.

Such tests, and others equally severe, assure you of a transformer finish designed to last the life of the transformer . . . eliminating rust, corrosion and expensive change-outs for repainting. You may expect even better paints in the future because Westinghouse is continually striving to find better ways to aid you in your battle with the elements.

For more complete details on Westinghouse "Coastal Finish" call your Westinghouse representative. Or—write now for Distribution Transformer Sales Letter No. 40. J-70703

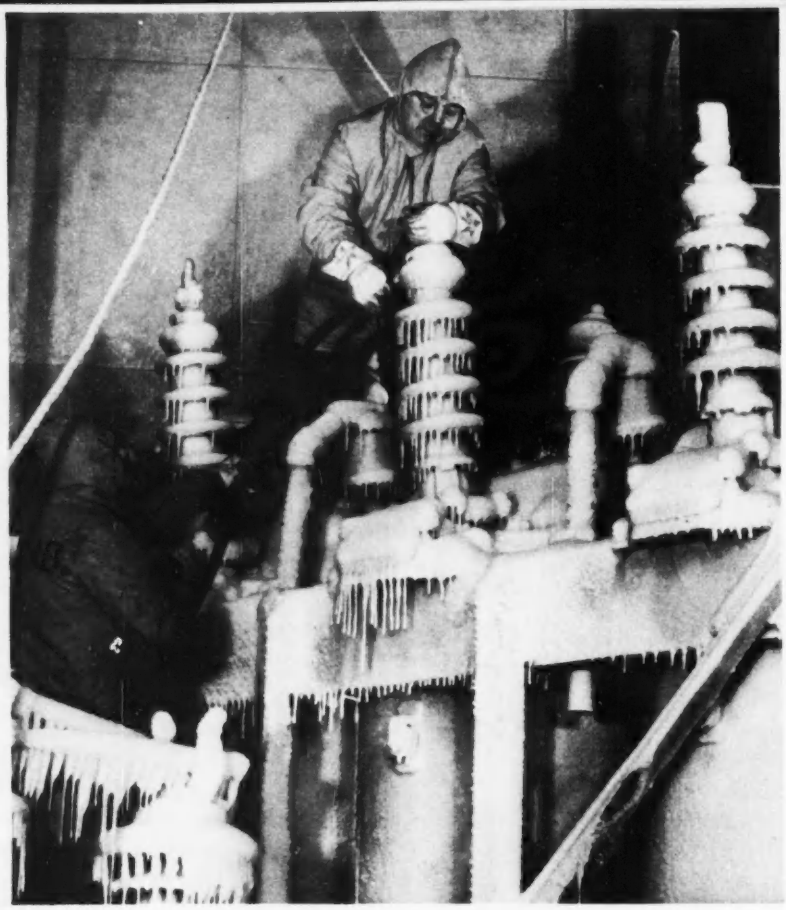
*Manager of Manufacturing Engineering

Westinghouse

A standard finish and "Coastal Finish" (right) transformer after being exposed to 1000 hours of salt spray.

Westinghouse Weather-O-Meter paint test which simulates average conditions of fog, rain and sunshine.

"Half the battle with the elements is won right in the laboratory where nature's worst is duplicated. Here's news about Westinghouse testing facilities."



We keep rain, wind, sleet and lightning on tap in laboratories throughout the country

Westinghouse products that help you fight the battle with the elements are not released until they prove they can take it in one or more of the company's 200 engineering laboratories. Here, elaborate equipment is used to duplicate within the laboratory a hundred or more varieties of weather. At any one time, it is possible that Westinghouse engineering laboratories are simultaneously subjecting equipment to rain, sea spray, sunlight, heat, dust, hurricane wind, tropical humidity, sleet, snow, earthquake and lightning.

Much of the test equipment is of special interest to the electric utility industry. For example, the Westinghouse High Power Laboratory has, as part of its regular test facilities, a cold room complete with refrigerating equipment and water sprays to produce sleet, ice and sub-zero temperatures down to -20°F for testing various switchgear equipment. The above photo shows equipment undergoing a cold test which in many cases is more severe than actual operating conditions.

Simulating nature is only one of the assignments of the engineering laboratories. They are an important element in the equipment design process—for only by laboratory tests can drawing board concepts be proved.

Perhaps one of the Westinghouse engineering laboratories has already discovered the answer to some equipment problem that is troubling you right now. If so, discussion of the problem with your Westinghouse representative will bring you answers that will save you time and money. CP-13 (1012)

• • •

For more information on the products described here, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

YOU CAN BE **SURE**...IF IT'S

Westinghouse

Testing Bench

(*Continued from page* 166)

cated under bench behind wire guard, for testing between ranges of 4 to 1 and 120 to 1. Indicating lights below switches show which standard is cut in. Main breaker switch is located at top center of board. Below this switch is bank of four toggle switches that set up circuits to binding posts for testing current or potential transformers. Also provided are two interchange switches which allow interchanging of standards to verify indicated output of transformer under test.

Row of binding posts mounted just above working area connect rotating standards into potential circuit (left side) or current circuit (right side). On each side is a switch for starting rotating standards.

For adjusting current or voltage on transformer under test, 10% and 2% tap switches to autotransformer are located at right of bench. Variac in series with 2% switch allows final adjusting of load. Bench is supplied from two 208-v generators driven by a single motor in another part of test shop. One generator may be rotated on its shaft to obtain variable power factors. Although power factor may be varied from zero lead to zero lag, normal range used in tests is from unity to 50% lag.

Loading box to right of bench contains 10-kva loading transformer and two standards with ranges of 5 to 800 amp and 1,200 to 4,000 amp. Novel feature of loading box is arrangement for positioning high-capacity standard. When not in use this standard rests down inside box on an elevator lift. This lift is operated by hand wheel to raise standard so that it may be rolled forward until heavy current leads overhang side of box. Through use of C-clamps, permanent lead on standard and temporary lead from loading transformer are attached to current transformer to be tested.

Light test leads run from secondary terminals on unit under test and standard to binding posts on either side of box front. These posts connect to posts on front of test bench.

Potential transformers are tested in enclosed safety area behind bench. Source for potential tests is 3-kva, 14,000-120-v distribution transformer. Across safety area is a gate equipped with two interlocks, either of which

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never a surprise
when you use
BERMICO®
FIBRE CONDUIT

Uniform wall thickness
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Uniform impregnation
Uniform quality of fibre

Automatic forming and processing . . . close controls over the drying process . . . machining of taper and length . . . four rigid factory inspections – these are the things that guarantee Bermico's uniformity of dimensions, specifications and quality.

For surest cable protection, be sure to specify Bermico Fibre Conduit. Made by Brown Company from sturdy wood fibre, impregnated with pitch, it is –

• Light • Tight • Strong • Waterproof • Acid-Resistant • Smooth Inside and Out

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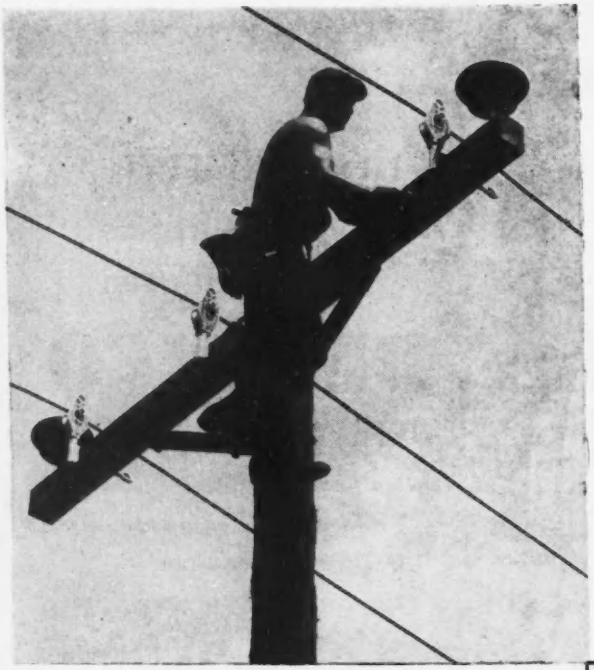
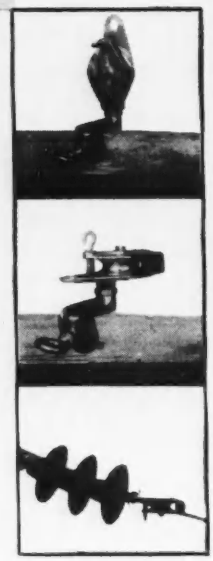
NIBROC TOILET TISSUE • BERMICO SEWER PIPE, CONDUIT ▲ CORES • ONCO INSOLES • CHEMICALS





NEW TRIPLE PURPOSE BLOCK

makes wire stringing cheaper and easier . . .

Considerable savings in time, labor and equipment costs result when the new Kenneloy block is used for stringing distribution and transmission conductors. Made of special high strength aluminum alloy with cadmium-plated steel fittings and a self-lubricating bronze sheave bearing, the block's light weight (8 pounds) makes it easy to handle on the job, easy to stow on the truck.

The block clamps to pole arm for either straight or angle pull or can be hung from insulator. No extra fittings or attachments are needed.

A special feature is the exclusive design of the sheave housing which has an overhanging lip that prevents stranded wire from slipping between sheave and housing. Breaking or stripping of conductors is completely eliminated.

Line superintendents have found that the Kenneloy block costs much less than any other equipment that will do the same jobs and is far easier to use.

Now available. Write us for literature, prices and deliveries.

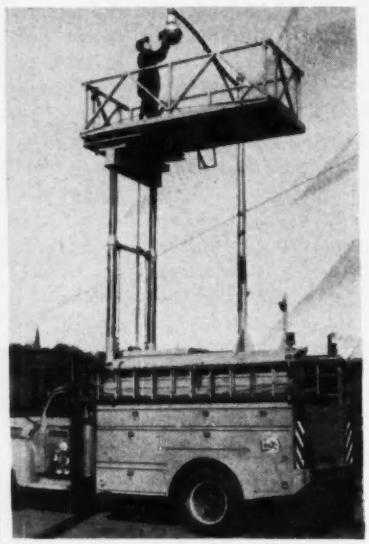
J. F. HODGKINS CO.

Gardiner, Maine

will trip main breaker if gate is opened by persons not familiar with the test area or electricians who may not know, or may forget, that units are under test.

Lift Truck Speeds Lamp Maintenance

Street lamp replacement has been simplified for Wisconsin Michigan Power Co's maintenance crew by a hydraulic tower truck which also, on occasions, is used for special jobs. Street lamps are changed on a group



HYDRAULIC LIFT TRUCK simplifies street lamp replacement for two-man maintenance crew of Wisconsin Michigan Power Co

moves easily from lamp to lamp and work is done quickly and with minimum effort on the part of maintenance men.

On occasions, the hydraulic tower truck has been used for:

1. Low branch tree trimming in urban areas.

2. Large substation bus work where clearances permit.

3. Large transformer maintenance.

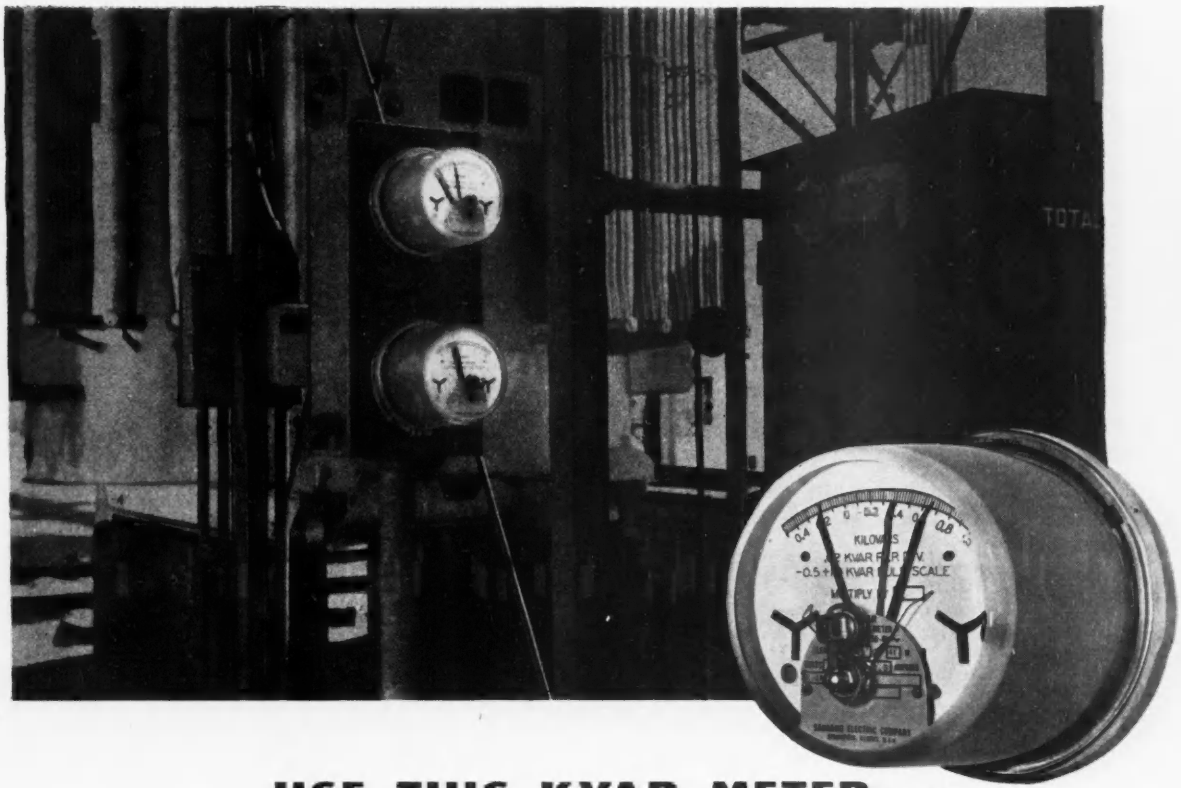
4. Service wire installation and maintenance.

5. Maintaining proper clearances of foreign contacts when stringing wire.

6. Raising conductors to provide temporary clearance for trench diggers and other equipment requiring temporary additional clearance.

7. Inspection of supervisory con-

KNOW THE REACTIVE IN YOUR SYSTEM



USE THIS KVAR METER . . .

one of the Lincoln "Indicating Meters with a Memory"

Distribution engineers are increasing system capacity by the application of capacitors to correct for reactive power which may be limiting full use of present facilities. This practice also effects economies in operation. However, accurate knowledge of the load at all times is vital to proper capacitor application.

Permanent installations of Lincoln KVAR Indicating Meters give these necessary facts. They tell the existing reactive demand, whether lagging or leading, and remember the full variation of the KVAR demand which occurred since resetting. Lincoln Meters are rugged and accurate, and they require practically no maintenance.

Full information is given in Bulletins 440 and 410. They're yours for the asking.

* * *

Have you received your copy of "Solving Distribution System Problems through Measurement"? It provides the answer to your load growth problems. We'll be glad to send you a copy.

SANGAMO
ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

Only Measured Facts are Known Facts

SM60-7

From Atomic Energy Plants to Rotogravure Presses . . .

From Power Plants to Perfume Producers . . .

. . . 42 Stories above Manhattan . . .

Deep Down in the Earth . . .

wherever hazards are tough or unusual . . .

CARDOX experience means dependable FIRE PROTECTION

When you buy fire protection, take a long, hard look into the experience of the people who plan and engineer it. It may mean your business survival—and the best way to judge is by what they've done!

CARDOX' experience in fire protection by low pressure carbon dioxide is on the record for all to see. For example, CARDOX Systems and Equipment* are protecting:

Vital equipment in atomic energy plants.
Much of the equipment in 14 of the nation's 25 largest utilities.
Practically all U. S. jet engine test cells.
The world's first continuous seamless pipe mill.
A radio station 42 stories above Manhattan.
Precious records in a deep underground vault.
The world's largest rotogravure press.
Even the ingredients of a perfume producer.

The list could be expanded indefinitely. This broad "know-how" of CARDOX—based upon *thousands* of successful Systems, *plus* years of research *is the priceless "extra" you don't pay for in every CARDOX System.* Why not write to see how we can help you?

*Covered by Patents, Issued and Pending.

CARDOX

ORIGINATOR OF LOW PRESSURE CO_2 FIRE EXTINGUISHING SYSTEMS

CARDOX CORPORATION • BELL BUILDING • CHICAGO 1, ILLINOIS

Offices in Principal Cities

trolled lead cables for gas leaks or for reringing cable.

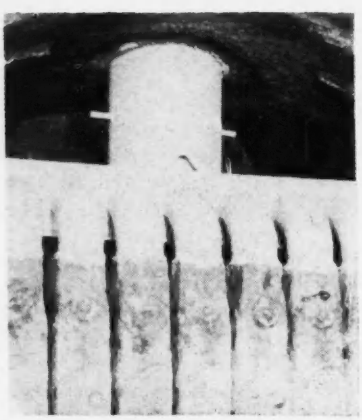
For these jobs the hydraulic tower truck is not standard equipment, and most work of these types has been done without it.

Header Sections Replaced with Elbows

WM. COWAN, Engineer, Horseshoe Lake Station, Oklahoma Gas and Electric Co, Oklahoma City

Replacing deteriorated steam header top sections in an evaporator with elbows resulted in considerable savings and speeded evaporator return

DETERIORATED TOP SECTIONS of headers in evaporator discovered during inspection



ELBOWS replaced deteriorated sections because other materials weren't available

to service at Horseshoe Lake station of Oklahoma Gas & Electric Co. O. E. Kitchen, supervisor in pipe fitting department, suggested cutting off top sections and replacing them with elbows because material deliveries were slow.

Victor No. 9 Pintypes undergoing routine electrical flashover, visual inspection, and final check for pinhole thread accuracy.

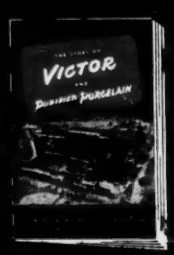
VICTOR PINTYPE INSULATORS

Must Pass These Tests!

1. **ROUTINE ELECTRICAL FLASHOVER**
   Every Victor pintype undergoes a routine electrical flashover test before shipment to insure trouble-free service.
2. **ACCURATE PINHOLE GAGING**
   Every lot of Victor Pintypes must be able to pass the standard NEMA test for pinhole thread accuracy.
3. **CAREFUL VISUAL INSPECTION**
   The finished insulator is thoroughly inspected for general appearance with special attention to smoothness of conductor and tie-wire grooves.

These tests assure almost unheard-of uniformity of service . . . unequalled ease of installation of pintypes. These features, coupled with the greater hardness, strength and resistance to impact of Victor *Purified Porcelain*, make Victor Pintypes the power man's best buy.

VICTOR NO. 9
LOW VOLTAGE
PINTYPE

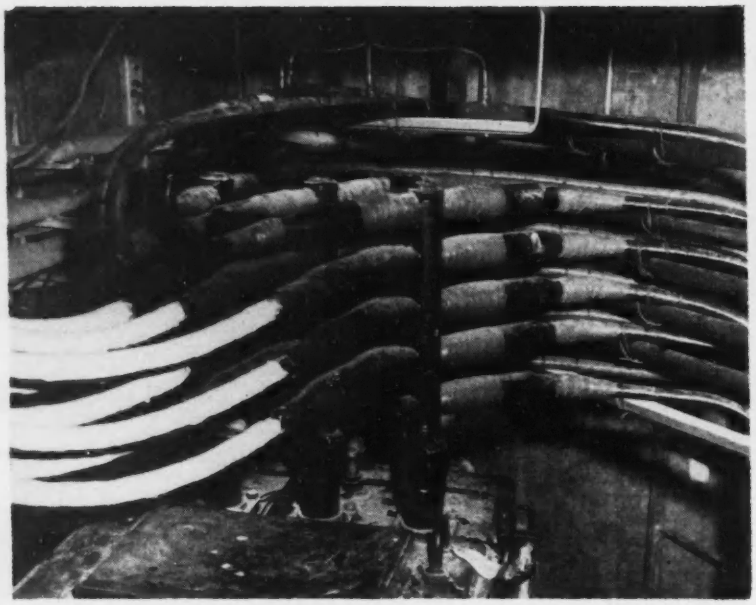


F... gives you the full sto... how Vic... Insulators are made... and why *Purified Porcelain* is ... veloped. V... as ...

Specify VICTOR INSULATORS!

VICTOR INSULATORS, INC., VICTOR, N. Y.

Low and High Voltage Pintypes • Suspensions • Guy Strains • Spools • Switch and Bus Insulators • Custom Designed Porcelain



INSIDE VAULT compact arrangement is obtained by use of T-shaped stud insulated multiple connectors permitting cables to be brought out from network protector 180 deg apart. A current limiter at each connector protects cable insulation in case of fault.

INSIDE BUILDING, insulated current limiter lugs, protecting 500 MCM cables, pick up load from C.T. enclosure to feed load centers

Insulated Multiple Terminals Solve Space Problem

MORRIS BRENNER, Associate Technical Service Engineer, Burndy Engineering Co, Inc, Norwalk, Conn.

Taking off 9–500 MCM cables per phase (and leaving room for an additional spare) in a crowded vault was one of the problems Meyer, Strong, and Jones (consulting engineers) faced in design of the electrical system for the Gateway Center, Pittsburgh, Pa.

Use of T-shaped stud insulated multiple terminals permitted cables to be brought out 180 deg apart. Conductors are attached to terminals through insulated current limiters which protect cable insulation in case of fault. Vault shown is located under sidewalk outside one of the buildings. The 500 MCM feeders go through concrete walls into building proper.

The feeders from the network protector pass through the concrete wall into a large metal enclosure housing the current transformers. The cable bus joins the flat bar by means of double clamping element terminals.

Load is picked up from the flat bar through insulated current limiter lugs which protect the cable insulation from damage in case of a fault in this part of the circuit. The 500 MCM, lead covered cable feeds into conduit at the bottom of the enclosure which in turn feeds the various load centers in the buildings. The neutral bus is carried along in the enclosure.

Selective Fusing Saves Breaker Replacement

L. J. LANGEVIN, Power Engineer, Cincinnati Gas & Electric Co.

Selective fusing provides adequate interrupting capacity on low voltage secondary network at the Gwynne Building, Cincinnati, Ohio which is served by 120/208-v, 3-phase, 60-cycle, 4-wire secondary network in the downtown area. The secondary grid of the network is tied solidly together, thus making possible large short circuit currents in case of a fault. Due to a recent load increase, a 600-kva network transformer was added. This increased the available short circuit current to the following values: symmetrical—73,000 amp, rms; asymmetrical—91,000 amp, rms. The interrupting capacity of the existing circuit breakers did not exceed 50,000 amp and they become inadequate when the new transformer was added.

Rather than go to costly replacement of the existing circuit breakers with new breakers of larger interrupting capacity, they decided upon the following solution which proved more economical. Five 1200-amp switches and special current limiting fuses rated 1000 amp were installed. The special fuse has 100,000 rms amp interrupting capacity at rated voltage and limits the actual short circuit current let through to a value which can be safely carried by the existing circuit breakers. The fuse is a high interrupting capacity fuse which functions as a short circuit protective device but also has overload characteristics that are the same as a standard cartridge fuse.

NOW...

AN IMPORTANT NEW SERVICE TO THE ELECTRICAL INDUSTRY

High-voltage cable pipe processed and Somastic coated to prevent corrosion . . . .

Here are the important features of this new service

- Internal grit blasting, cleaning and coating of pipe to protect high-voltage cables.
- Special preparation of pipe ends to permit a smooth pull of expensive cable between widely-separated manholes.
- Somastic pipe coating for protection against earth corrosion and electrolysis. (Specified for 96 per cent of high-voltage underground installations.)
- Hevicote applications for giving weight and protection to pipe in marine areas.
- Also, pipe bending, re-conditioning, welding, hydrostatic testing, hauling and stringing.

H. C. Price Co., "America's Foremost Pipeline Constructors," offers a complete cable pipe processing service to the electrical industry. For further information, write or call

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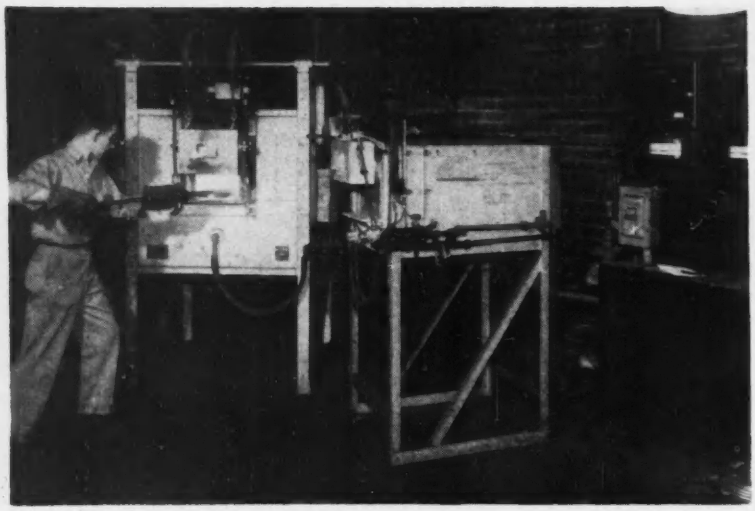


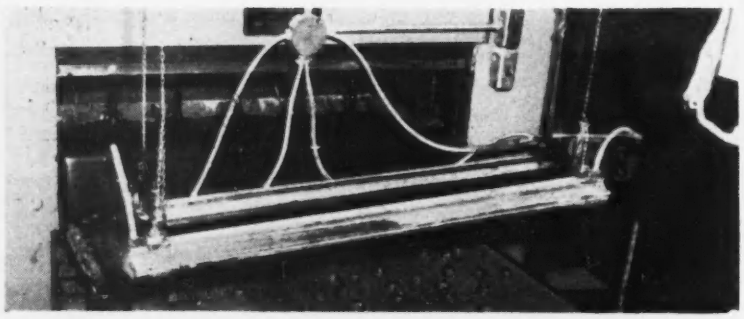
HEAT TREATING furnaces permit production of more and better machine tools at lower cost with greatly improved working conditions. Operator in picture has transferred a tray of high-speed saw teeth from 10-kw pre-heat furnace (at right) to 30-kw high heat furnace

Electric Furnaces Make Better Tools

R. L. CONBOY, Industrial Representative, Duquesne Light Co, Pittsburgh, Pa.

Working conditions were improved and rejects were practically eliminated after Hunter Saw and Machine Co, Pittsburgh, Pa., discontinued operation of some of their fuel-fired furnaces and installed four electric furnaces for heat treating. Among the items this company heat treats in these furnaces are high-speed steel saw teeth, rivet sets, chisel blanks and machine knives.

Officials of the firm are highly pleased with the results obtained from electric heat treating. Because of the precision control of electric heating, quality results are obtained consistently time after time. Rejects and reheating have been practically eliminated. The electric furnaces are well insulated, which conserves heat and contributes to better working conditions. Furthermore, the electric furnaces operate year in and year out with very little maintenance.



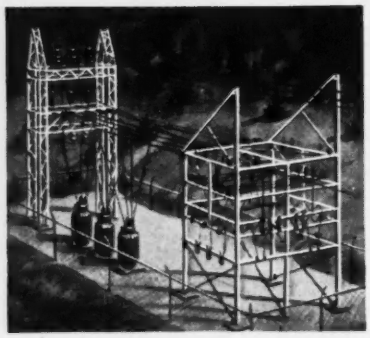
Candy Improved With Infrared

Preheating cream and other types of candy with two radiant infrared heaters before applying chocolate coating at Brock Candy Co, Chattanooga, Tenn., has speeded production over formerly-used method of storing candy in a warm room for some time before going through chocolate enrobing machine. The 1,800-w heaters placed at the entrance of the enrober, provide the correct amount of heat to bring the candy centers to approximately 180 F. Watt density is about 35 to 40 w per sq in. If candy is cold when chocolate covering is applied, it is likely to have a dull finish and show pores.

ADVERTISEMENT

Electrical Applications of Aluminum

Savings in Substations

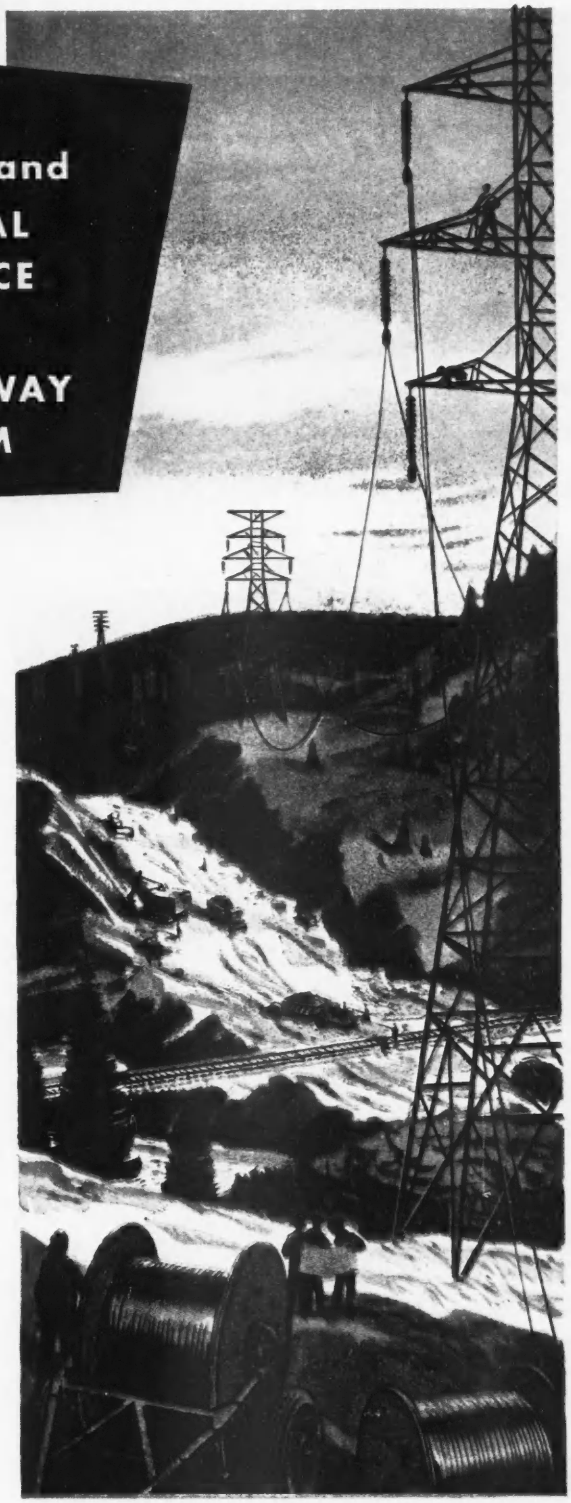


Important savings in erection costs and maintenance are prime reasons for the growing popularity of aluminum substations with utility companies, co-ops and large industrial users. The light weight and easy fabrication of aluminum permits faster, simpler erection. More shop assembled aluminum components mean less assembly at the job site—less skill is needed in assembly and anywhere from 3 to 7 days can be cut in erecting an average substation. No massive foundations are needed, grounding requirements are much simpler and field drilling is easier—more-savings thanks to aluminum. Substation maintenance costs are kept to a minimum because aluminum requires no painting—no costly shut-downs.

Master Reel and Coil Service

Reynolds offers a Master Reel and Coil Service that goes hand-in-hand with Reynolds ACSR toward saving time, money and labor. An all metal Master Reel sharply decreases handling, storage and bookkeeping costs. Four Master Reels take the place of 100 wooden reels. They're easily taken apart and re-assembled around the Master Coil by linemen in the field. Reynolds Master Coils hold the same amount of conductor as conventional wooden reels. They're carefully waterproofed, lagged and banded for complete protection in transit and on the job. For further details on this and many other applications of aluminum in the electrical field, write to the Reynolds Metals Company.

REYNOLDS ACSR and REYNOLDS ELECTRICAL ENGINEERING SERVICE solve a RAILROAD AND HIGHWAY CROSSING PROBLEM



A Missouri Corporation* recently asked Reynolds engineers for assistance with a particularly difficult section of line being relocated because of new highway construction. This section of line was about 2200 feet long and involved a difference of about 200 feet in elevation between the highest and lowest points in addition to railway and highway crossings. Reynolds engineers made complete recommendations for construction including sizes and types of conductor and overhead ground wires, height and types of structures, guying details and furnished complete sag and tension data. Full study was made by Reynolds on all related factors including strength, electrical conductivity, lightning protection and electrical clearance between conductors.

The experienced help of Reynolds Electrical Engineering Service is available without cost to Reynolds cable customers. This service, plus the savings in original cost, handling costs and field costs offered by Reynolds ACSR, make a combination that is well worth looking into. *Remember — Reynolds engineers will also be glad to conduct a meeting with your men and present design and fabrication information on all phases of electrical applications for aluminum.* *Name on request

ACSR MANUAL FOR ENGINEERS CONTAINS COMPLETE BASIC INFORMATION, CHARTS AND TABLES. This book is available without charge when requested on your business letterhead.

For complete information

see your Reynolds distributor listed below
or write direct to Reynolds Metals Company
2584 South Third Street, Louisville 1, Kentucky.

A. A. Electric Supply, Chicago • California Electric Supply, San Francisco
General Electric Supply Co., Bridgeport (and branches) • Hendrie & Bolthoff, Denver
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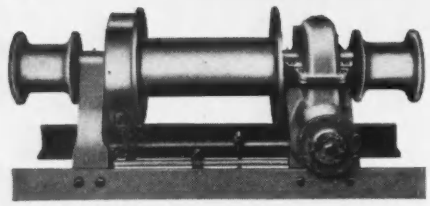
"Mister Peepers" returns September 13th on NBC-TV.

REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND

TULSA* WINCHES



The Model 23 Tulsa Winch is installed on the truck below. There are 27 other models in capacities from 6,500 to 80,000 lbs. for all makes and models of trucks and crawler tractors.

FOR HAULING...

Loading and unloading 3-ton cable reels is a simple task for this California trucking contractor. Working for a West Coast public utility, the driver easily, quickly and safely handles these reels of expensive copper cable. His Model 23 Tulsa Winch does the entire job.

Tulsa* Winch
TULSA, OKLAHOMA
DIVISION OF VICKERS Inc.

*Reg. U. S. Pat. Off.

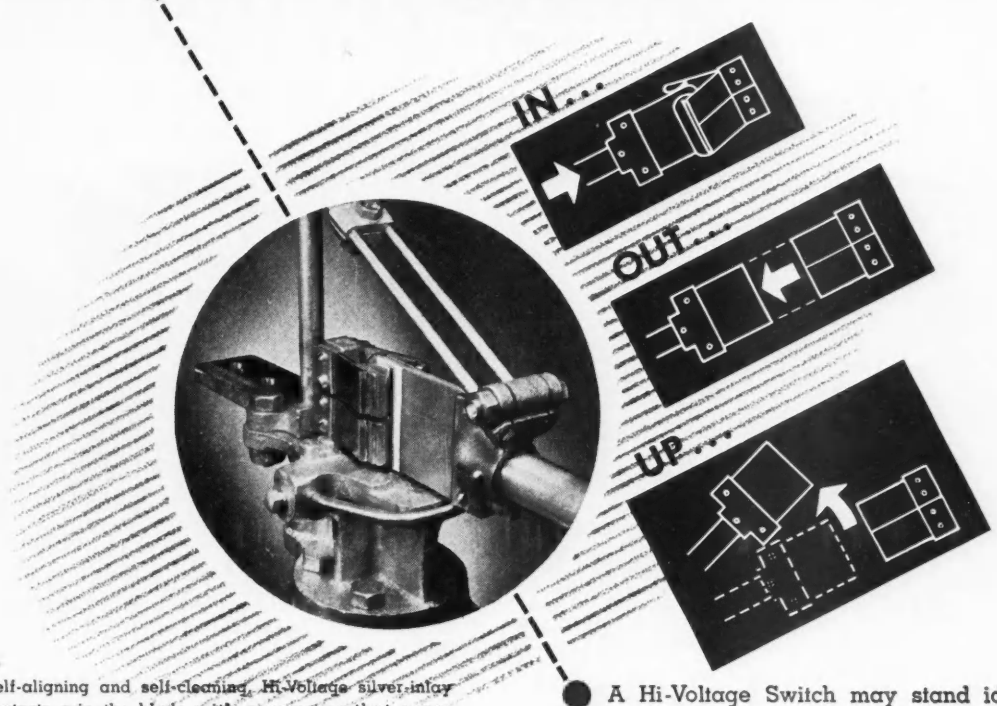
INDUSTRIAL BRIEFS

Heating air compressor cooling system with 2-kw electric heater to keep oil fluid in cold weather at Chas. W. Lundgren's Memorial shop, Lancaster, Pa., has solved problem of blown fuses when starting compressor on cold mornings. Cooling system is a free convection type which is adaptable to this type of heat. Thermostat controls heater and keeps compressor ready for easy, trouble-free starting at any time. Robert Smith, Industrial Representative, Pennsylvania Power & Light Co, Lancaster.

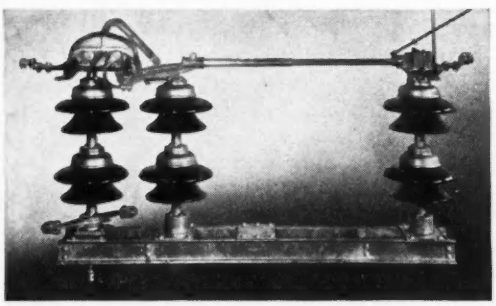
Drying ink on printed vinyl plastic advertising cards in electrically heated cabinets saves a full day's time on job presses at Alfray Products Co, Coshocton, Ohio. Cards are printed in two colors on both sides. On small orders the press would have to stand idle while ink dried so that backs of cards could be printed. Portable cabinets were built with removable wooden racks for the cards. Four 250-w infrared heat lamps were installed in bottom of each cabinet and directed at two sheet metal baffle plates which heat air entering through open bottom of cabinets. Drying time for each printing has been reduced so that press can be changed to second color immediately and cards run through press again. Two cabinets are used for each job press and as soon as pressman has filled cabinet it can be moved to packing tables and reconnected so that packers can inspect and package first cards printed. Doren A. Sauers, Jr., Industrial Power Engr., Ohio Power Co, Coshocton, Ohio.

Lowering moisture content of experimental papers at Herty Laboratories, Savannah, Ga., is accomplished with infrared lamps. In making experimental runs on a miniature paper machine, it is often desirable to reduce moisture content of the paper approximately 2-3% more than the heated calender. A bank of 48 250-w infrared lamps was installed which can be fully or partially operated to give the desired amount of moisture content in the finished product of experimental paper. C. D. Anderson, Power Sales Engineer, Savannah Electric Power Co.

"IN...OUT" SWITCH ACTION *means* *CERTAIN* OPERATION



Self-aligning and self-cleaning, Hi-Voltage silver-inlay contacts grip the blade with a pressure that never varies because of the ageless flexibility of the stainless steel springs.



Ask your Joslyn Representative to show you the many money saving advantages of Hi-Voltage Switches.

A Hi-Voltage Switch may stand idle for years, but when it is called upon to operate, it performs without any hesitancy, even if encased completely by ice.

The main reason for this "certain operation" is the straight push-pull, close-open action of the switch arm. There is no twisting or turning. After clearing the contact housing, the arm is swung completely open by the powerful and precision-built operating mechanism. Closing is simply a reversal of the opening action.

Other outstanding features include silver-nickel, positive-pressure contacts; exclusive contact housing; corrosion-proof operating mechanism; Monel ball bearings; and an engineered operating shaft.

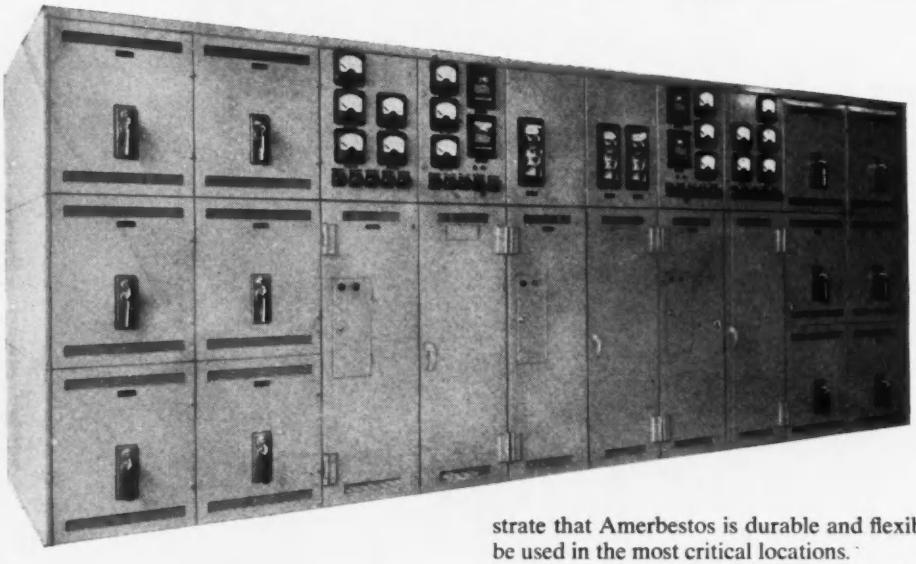
For certain operation . . . anytime . . . under any condition . . . select the switch with the protected "in-out" contact action.

HI-VOLTAGE SWITCH RATINGS: 200 to 3000 AMPERES; 7500 to 287,000 VOLTS

HI-VOLTAGE EQUIPMENT COMPANY

4000 EAST 116TH STREET • CLEVELAND 5, OHIO

"We've got to have a and we're getting



I-T-E says, "Our switchgear goes into central power plants that serve entire cities. The failure of *one wire* could shut down a million-dollar turbine and cause a total power blackout. Process plants could lose millions in ruined products and interrupted produc .on. The stakes are too high for us to use anything but a top quality wire, and we're getting it with Amerbestos."

For the switchgear shown here, I-T-E uses U·S·S Amerbestos 90C type TA: copper strand—thermoplastic insulation—felted asbestos—flame-resistant cotton braid. The homogeneous thermoplastic insulation gives excellent moisture protection; and, even more important to I-T-E, it can be bent to a much shorter radius than helically-wound insulations. As a matter of fact, I-T-E found that after a bending test, this type of Amerbestos construction could withstand a breakdown voltage *20 to 30 times* higher than helically-wound insulations. While this was an unusually severe test, it does demonstrate that Amerbestos is durable and flexible enough to be used in the most critical locations.

Since the very reputation of I-T-E is built upon the high quality of their product, they demand close quality control from suppliers, too. "And," says I-T-E, "We know that American Steel & Wire checks, tests and inspects every foot of wire we get." I-T-E also remarked that the Amerbestos conductors are always well centered in the insulation, and the thermoplastic insulation shows no tendency to flow or become brittle.

You can get this same high quality from American Steel & Wire no matter what kind of wire or cable you use. Send the coupon and get more information about Amerbestos; or, better still, outline your wire or cable problems and give our engineers a chance to help you.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

A STANDARD Cable for every

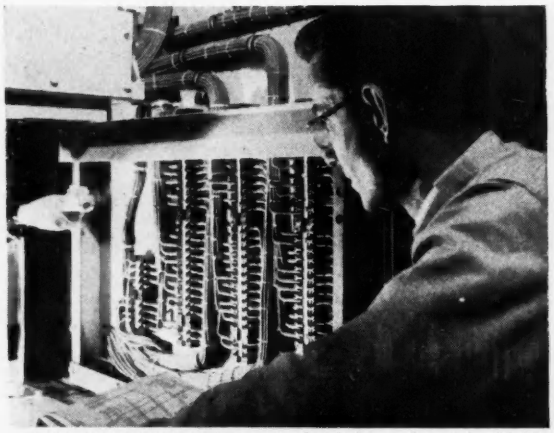
- paper & varnished cambric cable
- asbestos wire and cable
- aerial, underground & submarine cable
- shovel & dredge cable

AMERICAN STEEL & WIRE DIVISION
USS
AMERICAN ELECTRICAL WIRE AND CABLE
UNITED STATES STEEL

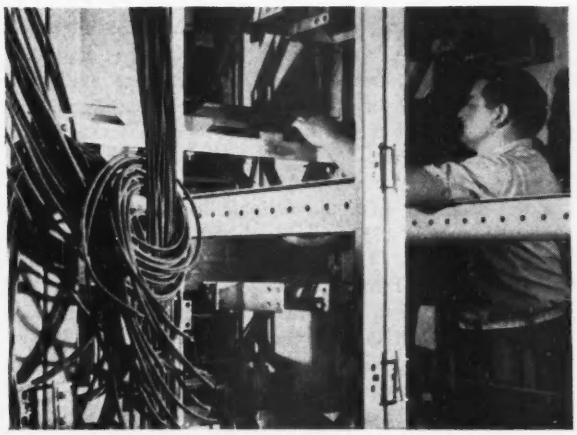
U·S·S AMERICAN ELECTRICAL

top quality wire it with Amerbestos"

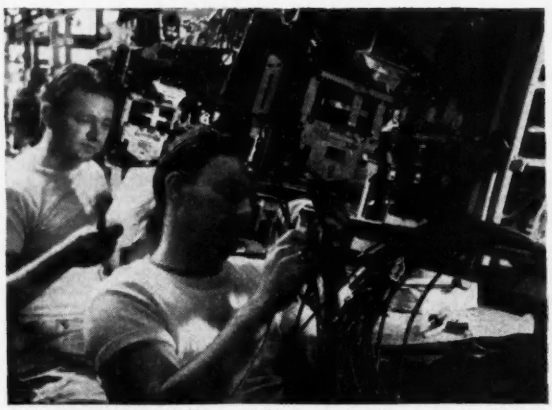
says I-T-E Circuit Breaker Co., Inc., *world-famous switchgear manufacturer*



THIS LOW-VOLTAGE BOILER control switchboard contains 22,000 feet of Amerbestos. It has 11 circuit breakers, is being built for Astoria, N. Y. generating station of Consolidated Edison.



HERE, an electrician wires a 600v I-T-E Multimite switchboard. It has 9 compartments, 7 for circuit breakers, 2 for instruments. Notice extreme flexibility of the Amerbestos wire.



EACH OF THESE I-T-E type KB circuit breakers contain 22 feet of Amerbestos. In this photograph, workmen are wiring the circuit breakers up to the terminal blocks.

UPPER SECTION of this photo is the main power bus on the Consolidated Edison switchboard. Wiring duct cover has been removed to show the 298 wires that occupy the compartment.

SPECIAL Job!

- **mold cured portable cord**
- **machine tool & building wire**
- **special purpose wire & cable**

WIRE & CABLE

SEND THE COUPON

American Steel & Wire Division
Room EE-83, Rockefeller Building
Cleveland 13, Ohio

☐ **Please give me more information about Amerbestos**

☐ **I'd like to talk to your representative**

Name .....

Firm .....

Address .....

City ..... **State** .....

USS

UNITED STATES STEEL

Ceico-Builder Teamwork Spurs Residential Sales

Cleveland Electric Illuminating Co has been steadily increasing its percentage of residential sales through an extensive program of cooperation with local builders.

Its percentage of residential to total electric sales has inched up from 13.8% in 1947 to 17.4% last year; demand of less than 50 kw (commercial) accounts for 8.1%; demand of 50 kw or more (industrial) for 64.6%; and other, 9.9%. Though residential sales figures are below the national average of 25.3%, company officials point out two factors that make the record more impressive than the figures indicate.

First, Ceico's residential customers use considerably more electricity than the national average—2,304 kwhr per customer in 1952, compared with 2,175 kwhr for the industry.

Second, the record rates of home construction that were established in the area in 1950 and 1951 continued into 1952, when they exceeded the national average by 25%. Though predictions are for a 10% drop in home construction in the area this year, home building will still be well ahead of the rest of the nation.

Healthy Prospect . . . These two factors, coupled with the heavy industrial concentration in the company's service area, lead officials to believe they have achieved a healthy balance between residential and industrial customers.

Lending a hand to builders in every phase of their activity, from planning number of starts to bringing lines in to serve new areas, has helped Ceico to add 50,000 new residential meters in the period between April, 1950, and April, 1953.

Robert Heinton, now Ceico's manager of marketing, has sparked the program, which started shortly after the end of World War II. Through his Industrial Sales Department, Heinton keeps tabs on industry's plans which will add workers to payrolls. A study made in Cuyahoga County in 1950 showed that for every 1,000 new workers added, 700 additional dwelling units were needed.

It is the Residential Sales Department that actually carries the ball with builders. The department is broken down into three territories, with 15 sales representatives and three supervisors serving a 4-county area. The district sales representatives maintain a regular schedule of calls on builders so they know their plans. By knowing these well in advance, construction delays due to lack of power are avoided.

Sales Talk Given . . . During construction, sales representatives advise builders on wiring questions and—naturally—plump for as many electrical appliance outlets as possible. One builder says that as a result of this advice, 80% of his homes are built with circuits for electric ranges.

If the builder is developing a new section, the representative tries to promote a model home, featuring an all-electric kitchen, laundry, and electric water heater. He also recommends all types of lighting as a "buy appeal" factor, on the basis that it improves appearance of the home and permits the builder to show it for longer hours.

AFTER Ceico's R. C. Heinton (seated) confers with L. T. Blackman, president of Home Builders' Association, about building plans . . .

. . . utility's J. T. Yeilding and R. J. Stancik (left) discuss action with L. O. Young and Karl Kuhn, representatives of Allied Mortgages

When model homes are featured, Ceico helps prepare cooperative newspaper ads. Representatives arrange with dealers or distributors to install ranges, refrigerators, etc., in the model homes.

This program has increased demand so much, says Ceico, that this year it has had to restrict the number of homes each sales representative can arrange for.

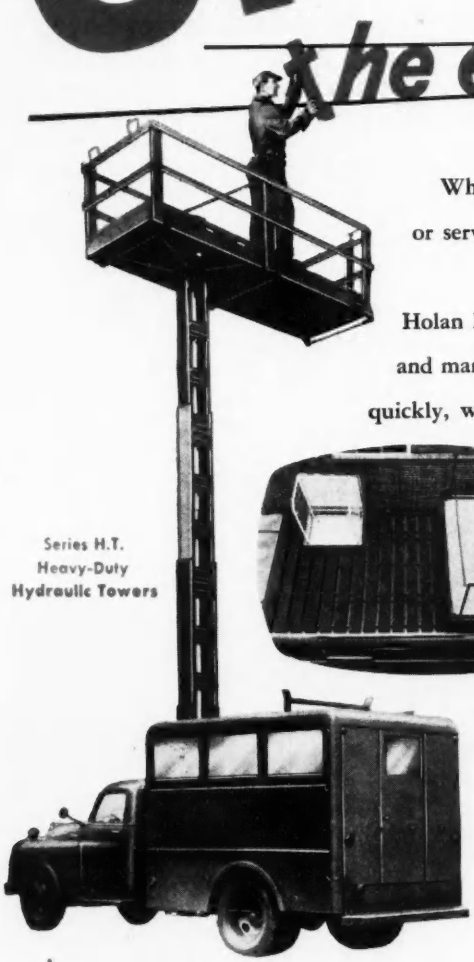
Other Duties . . . The representatives also attend meetings of the Home Builders Association to gear themselves to plans of most of the volume builders. However, they don't restrict their activities strictly to association members.

One of the most important phases of the program is the

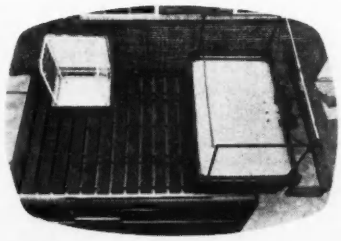
UP and at it!

the easy way

Wherever construction, maintenance or service must be spotted quickly and safely on aerial jobs, Holan Hydraulics are favorite with men and management. They are raised and located quickly, with minimum effort. They are retracted and moved to the next job without delay. The engineered simplicity and strength for which the name Holan is famous assures a long life of low-cost, high-return service. Towers or ladders, with choice of several sizes.



Series H.T. Heavy-Duty Hydraulic Towers



Holan personnel lift, available as a special feature on Series 1300 Hydraulic Towers eliminates climbing outside. Specially valuable for globe washing, where it saves many hours, cuts fatigue.

New Series 2100 all-hydraulic Aerial Ladder

Holan Heavy-Duty hydraulic towers have stationary, rotary or transverse platforms. Extra rigid telescoping box channel type lift. A choice of models with maximum platform heights of 17', 23' 6", or 30'. All can be lowered to 10' 3".

In the new Series 2100 all-hydraulic ladder, every motion, rotation, elevation, extension *and retraction* is hydraulically actuated. Powered by integral gasoline engine, or by power take-off. Choice of 27', 31' or 35' *platform height.*

J. H. HOLAN CORPORATION

The dependable name in utility bodies

MOBILE EQUIPMENT FOR PUBLIC UTILITIES

4100 West 150th Street • Cleveland 11, Ohio

Distributors

BAKER EQUIPMENT ENGINEERING CO.
Charlotte, N. C. • Columbia, S. C.
Richmond, Va.

SCHETKY EQUIPMENT CORP.
Portland, Ore.

District Sales Representatives

6-03 161st Street, Beechhurst, Queens, New York • 201 S. El Camino, San Mateo, California
2754 N. 92nd Street, Milwaukee 10, Wisconsin • 863 Wilson Drive, New Orleans, Louisiana

Export Representative

COPPERWELD STEEL INTERNATIONAL • 117 Liberty St., New York 6, N. Y., U.S.A.

Another Load of:

Haley's

CEDAR POLES
and
FIR CROSS ARMS

Light in weight and clean. PENTAchlorophenol treated in our modern plant for protection against decay, moisture and insect damage.

TWO strategically located yards:
MINNEAPOLIS, MINNESCTA
FINDLAY, OHIO

R. G. HALEY & CO.
SPITZER BLDG.
TOLEDO 4, OHIO

help given builders in securing loans to carry out their construction plans. Eighteen months ago, two Ceico men toured the country calling on 33 insurance companies to promote the idea that mortgage-loan investment opportunities were plentiful in northeastern Ohio. A similar canvass was made of savings companies to have them allocate more money to the area.

If a builder hasn't established contact with a mortgage company and needs such service, Ceico representatives will make the contact for him. In addition, they work closely with city officials on questions of zoning, city and regional planning, obtaining better water supplies, and sewage disposal systems for municipalities.

Through Ceico's knowledge of industry's plans, public officials are kept abreast of growth trends so they can do a better job of planning for additional services and keep in step with the rapid commercial and residential expansion that accompanies it. Work with officials on street lighting programs and other civic projects that are helpful to the communities are another phase of the program. A Ceico man also is a member of Cleveland's Mayor's Advisory Committee for Rehabilitation, for improving homes which are basically sound.

Disposals Easy on Water, Professor's Survey Shows

Modern food disposals increase water usage in the average family less than 1%, according to a study recently completed by Prof Kenneth W. Cosens of Ohio State University's department of civil engineering.

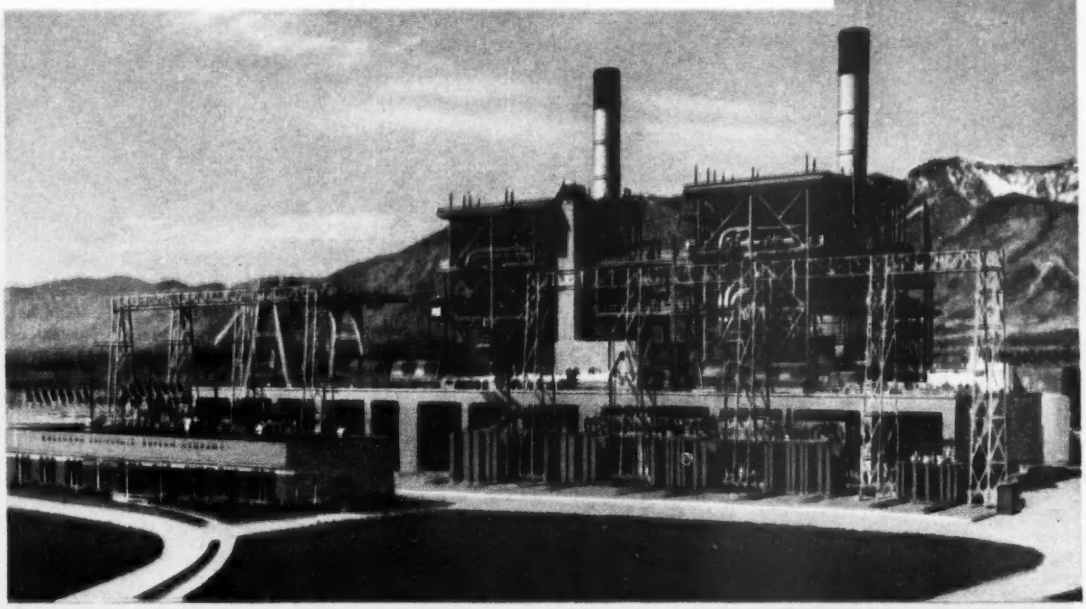
Professor Cosens used four families in the study, equipping the grinder portion of the disposal with separate meters to record flow of water when the grinders were in operation. Amount of water averaged 1 1/6 gal per person per day, during the year-long test. Compared with the national average water consumption in the U. S. of 127 gal, the amount used per person in the test homes equalled .9% of the total average consumption.

Putting Some Snap into Appliance Sales

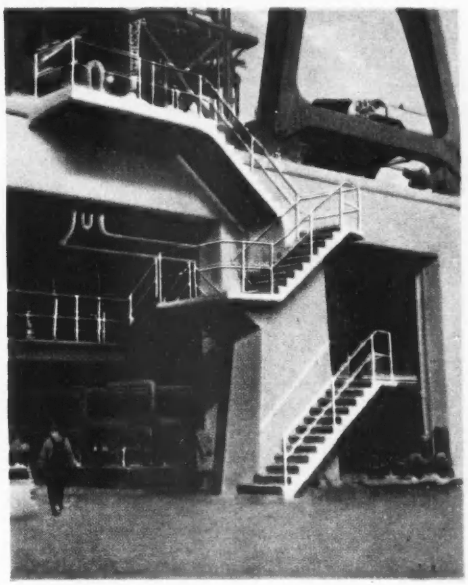
Electrical appliance sales have snapped out of the doldrums in Sacramento, Calif., following a 4-day electrical home show presented by Sacramento Valley Electric League. Appliance dealers attribute increased business to their displays at the exposition held in the city's largest auditorium. One of the 53 exhibitors estimated $10,000 worth of future business will result from his display, while another reported on-the-spot sales of $1,200. Total attendance at the second annual show was 13,866.

ETIWANDA

Economical as all Outdoors



Etiwanda Steam Station of Southern California Edison Company, located in the fast-growing Fontana District near Los Angeles, has an initial capacity of 250,000 kw. It was designed and built by Stone & Webster Engineering Corporation, in collaboration with the client's engineering department.



Etiwanda Steam Power Station was designed for efficiency, ruggedness, simplicity – and economy.

The station, largest in the country to use cooling towers for circulating water, is almost entirely "outdoors". This and other features of the design have achieved outstanding economy in plant cost combined with high thermal efficiency and minimum operating costs.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

HIGH **BELL'S** ALTITUDE

WESTERN RED CEDAR POLES

DOUGLAS FIR AND WESTERN LARCH POLES

Machine shaved Western Red Cedar Poles at Bell's Minnesota Transfer Plant with incised ground line area full length non-pressure treated in five per cent Pentachlorophenol solution.

Painstaking Operations that assure Maximum Service Life

PRODUCTION CONTROL in the woods assures guaranteed quality pole timber.

LABORATORY FACILITIES AND METHODS at the plant assure new high standards of quality in preservative treatment with Pentachorophenol solution or Grade One Creosote Oil.

PRECISION FRAMING assures neat, accurate slab gains cut to any depth or length — single or double cut — to specified thickness between gains — absolutely accurate bolt holes — smooth and neat roofing cuts.

•

BELL POLES set a new high standard in all around quality. Continuing research, modern pole processing plant facilities, and expert supervision from tree stump through the preservative processing to the finished pole on the line combine to provide poles of finest appearance and quality. Make use of BELL'S more than 50 years production experience as a dependable source for transmission and distribution poles.

BELL 1953 LBR. & POLE CO.

BELL LUMBER & POLE CO.

Minneapolis, Minn.

Fuses Remote . . .

. . . on electric ranges, survey by Electrical Testing Laboratories shows

Fuses on leading models of electric ranges are not as accessible as is desirable, according to tests conducted recently by the Electrical Testing Laboratories, Inc., New York City.

The organization made a study of locations of fuses in five electric ranges and the time required to change them. Ranges were set up under good lighting conditions.

Eight men and four women participated in the test. A plug-type fuse was placed on top of the range and each observer was asked to locate and replace a blown fuse. All range parts such as panels and drawers were to be replaced as found.

Procedure was repeated on another day, thus making it possible to determine the time to change the fuse, first without and then with previous knowledge of its location. Speed with which they did their work is recorded in the accompanying table.

In one instance the fuse holder was held in place by a threaded ceramic bushing. One observer unscrewed the bushing instead of the fuse, with the result that a normally live part came in contact with the frame of the range.

	Av. seconds to change one fuse	
Range No.	First trial	Second trial
1	32	16
2	224*	85
3	67	41
4	15	12
5	77	27

*Exclusive of two observers who gave up after failing to locate fuse in 195 and 410 seconds.

GE's Heat Pump Now a "Weathertron"

A new name, "Weathertron," and a new science, "Weathertronics" will be used in describing General Electric Co's heat pump and the company's activities in the heat pump field.

In announcing the designation, H. M. Brundage, general manager of the newly-christened Weathertron department, predicted that units operating on heat pump principle will sell at a rate of $400 million a year by 1962.

HERE'S THE EXTINGUISHER YOU PICKED AS "EASIEST TO USE" OVER THREE OTHER LEADING BRANDS . . .

Randolph

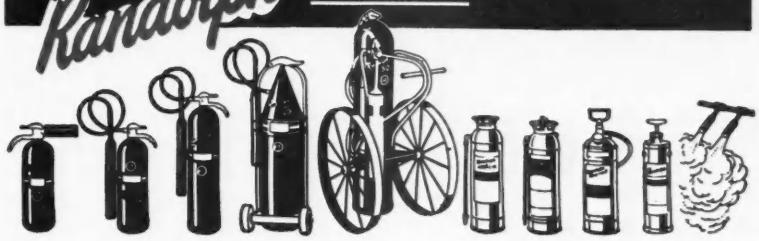
Safety and Plant Engineers—here's how you voted: In a national survey recently completed, 100% of your replies stressed *ease of operation* as a major factor in Extinguisher selection. And on the basis of being "easiest to use", 86% of your replies specified Randolph over the nearest brand—66% specified Randolph over *three* other leading brands, *combined!*

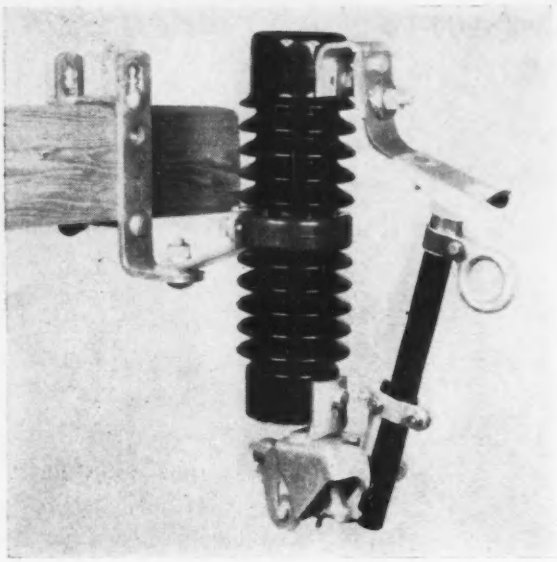
With no nozzles to adjust, no valves to turn, Randolph Extinguishers are 100% panic-proof. Just snap from the bracket, aim and press the trigger. You KNOW how to use this extinguisher *just by looking at it!*

COMPLETE LINE OF EXTINGUISHERS AND AUTOMATIC EXTINGUISHING SYSTEMS

Make sure your plant is mobilized for fire . . . with easy to use, simplified RANDOLPH Equipment. Sizes from 2½ to 50 lbs. Manual and automatic systems. Write Randolph Laboratories, Inc., 12 E. Kinzie St., Chicago 11, Illinois.

Randolph SIMPLIFIED FIRE EQUIPMENT





Cutouts

A new improved line of open-dropout fuse and load-break cutouts, providing good fault protection or opening of circuits under load, has been announced. New features claimed for the line are as follows:

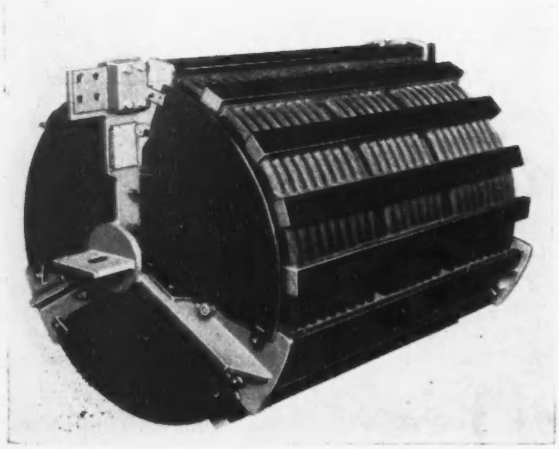
1. A hollow-tube, wet-process, porcelain insulator with the mounting support clamped to the porcelain by a "U" bolt insulated with rigid polyvinyl chloride insulation, for achieving birdproof construction.

2. A shielded top contact and latch for protection from dirt or sleet.

3. Top and bottom fittings are compression-bolted to porcelain for mechanical strength.

Ratings of 7.8 and 15 kv, 100 amp, are available. Three interchangeable fuseholders provide 2,000-amp interrupting rating, 5,000-amp interrupting rating, and load break up to 100 amp.

General Electric Co, Schenectady 5, N. Y.

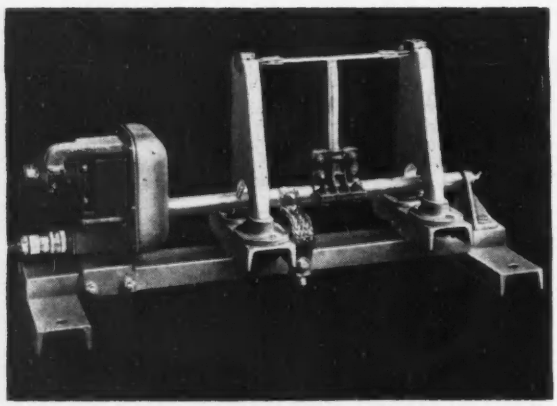


Line Trap

A new line trap (Type M) with a continuous current rating of 1,200 amp has been developed to operate as a blocking filter. It is said to offer high impedance to carrier current but negligible impedance to power current. Trap is 51 in. long and 34 in. in diam.

High current-carrying capacity results from arrangement of coil conductors and use of molded posts disposed around the conductors. Posts are made from a mica-filled plastic, which has high strength, resistance to temperature and weather, and good electrical properties.

Westinghouse Electric Corp, Pittsburgh 30, Pa.



Shorting Switch

A new high-frequency shorting switch for two-wire open transmission lines having 12-in. spacing has been announced. It reportedly causes a minimum of line disturbance in the open position and is rated at 30 kv wire-to-wire or 15 kv to ground.

The heavy steatite-insulated shorting bar is controlled by a low-voltage dc motor equipped with limit switches and an electro-mechanical brake. Mechanical link between motor and switching arm disengages at end of stroke so that the switch may be hand operated.

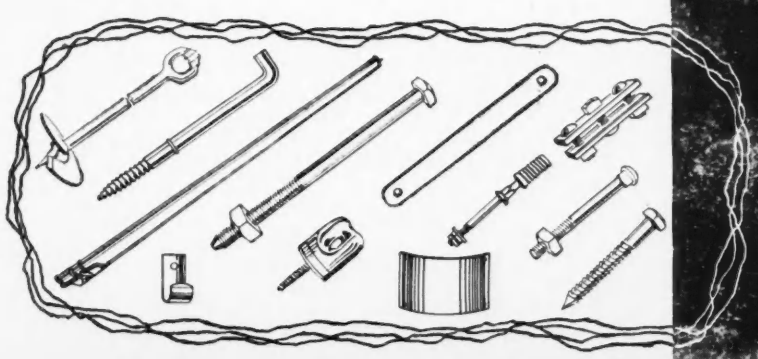
Wind Turbine Co, West Chester, Pa.

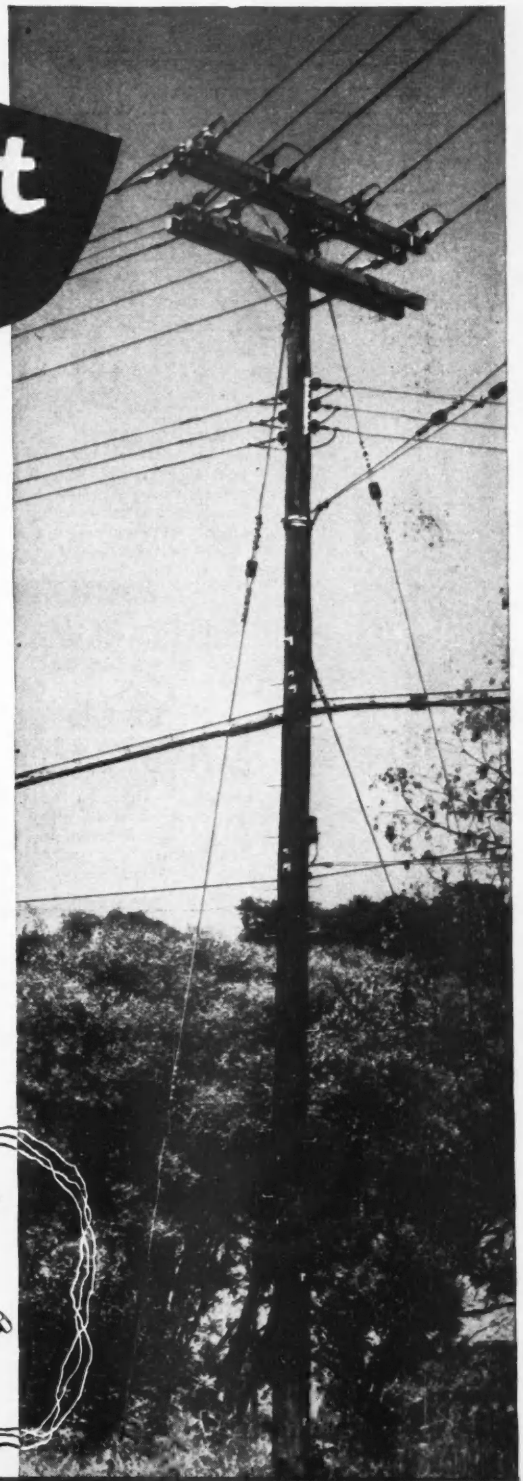
ARMED *Against* TROUBLE

with HUBBARD Pole Line Hardware

HUBBARD'S 4000 items of Pole Line Hardware are planned to save the Lineman and the Line. From arm to anchor, every product is designed for easy installation and long-life protection. All steel is Hubbard Double Dip Hot Galvanized to stand in all kinds of weather through the years.

Hubbard Hardware is manufactured in three strategically located Hubbard Plants in Pittsburgh, Chicago, and Oakland, California, and is carried in stock by more than 200 leading Electrical Distributors throughout the United States. There's a Hubbard Distributor near you.





HUBBARD AND COMPANY

ESTABLISHED 1843

PITTSBURGH • CHICAGO • OAKLAND CALIFORNIA

"Hang the Load on Hubbard Hardware!"

5 reasons for specifying RT&E TRANSFORMERS

5 HIGH IMPULSE LEVEL
Impulse level with built in safety factor considerably exceeds industry standards and is accomplished by—low layer insulation voltage stress—stepped back and graded overinsulation—space wound windings at coil ends—taps positioned in center of H.V. windings.

4 OIL FILLED PRIMARY BUSHINGS
Primary bushings are a wick-fed oil-filled type to eliminate corona and radio noise.

3 EXTERNAL TAP CHANGER
All tap changers are externally operated to avoid opening of unit—breaking of factory cover seals—contamination of oil from moisture and dirt—provides a greater convenience for tap changing and tap position identification in a matter of seconds. Unit remains sealed for longer life.

2 STANDARD 5 YEAR GUARANTEE
All RT&E transformers are guaranteed for 5 years from date of shipment from factory, free from defective workmanship and materials.

1 D. B. P. C. (inhibited oil)
All RT&E transformers are inhibited with D.B.P.C. to reduce oxidation—sludge—corrosion—acid formation and to increase transformer life.

SIZES
3 THRU 500 KVA
2400 TO 14,400 VOLTS
SINGLE & DOUBLE BUSHINGS

WRITE FOR CATALOG

632 N. 8TH ST. MILWAUKEE 3, WISCONSIN

RT&E Co.

BRANCH PLANT: WAUKESHA, WISCONSIN

Voltage Tester

A voltage tester has been announced that will show nominal line voltages from 110 to 550 v ac and 110 to 600 v dc, as well as distinguish between ac and dc, and show dc polarity. Safety features claimed for the solenoid operated tester include:

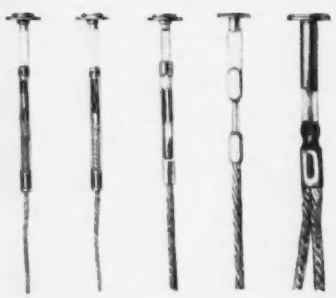
1. Prod handles that are integrally molded to Neoprene insulated leads, and include tip insulation and safety rings.

2. One-piece sturdy plastic case that is completely enclosed.

3. No exposed metal on the case exterior.

4. A neon lamp in parallel with solenoid to provide a double check on circuits.

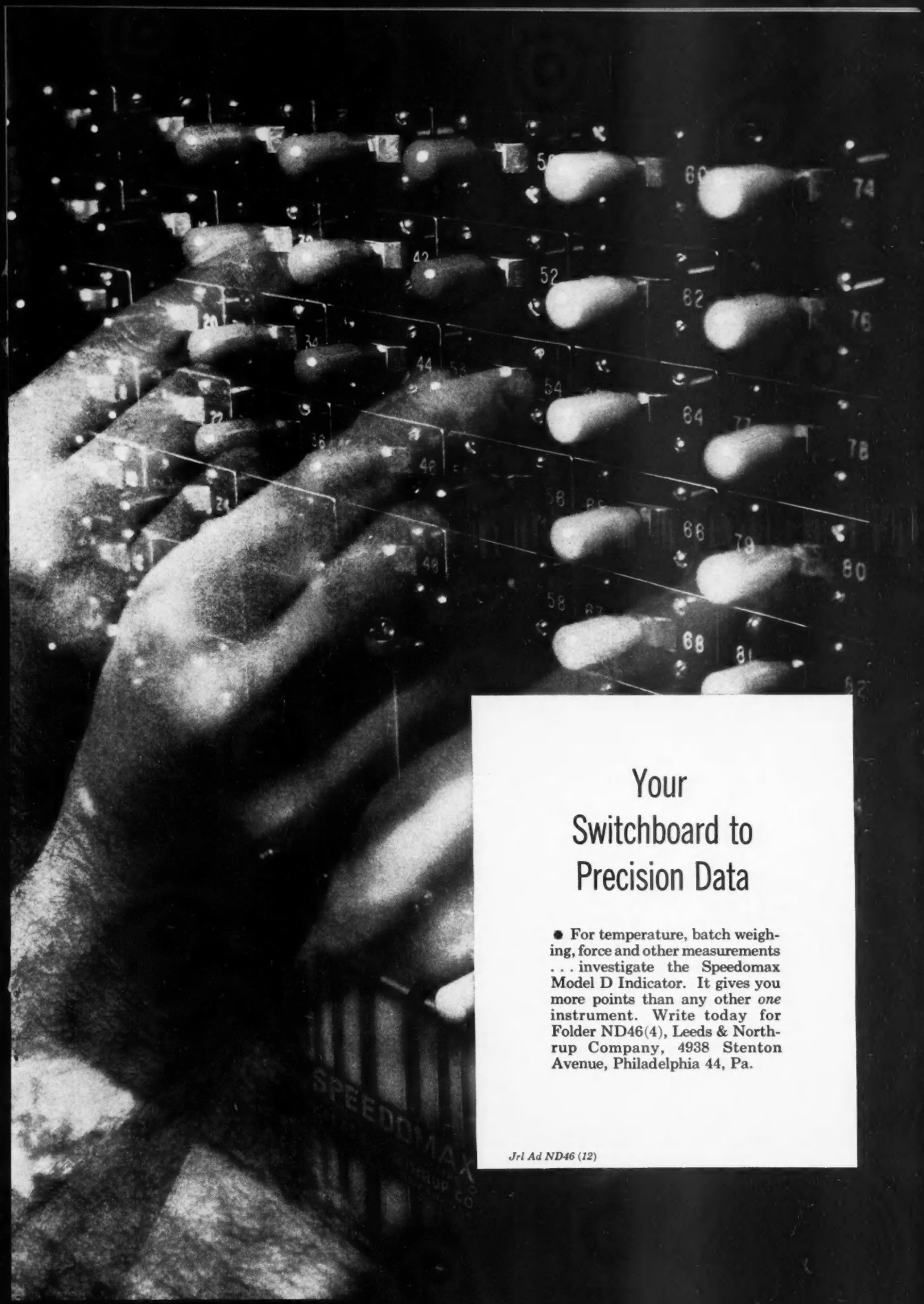
Ideal Industries, Inc, Sycamore, Ill.



Fuse Links

A complete line of fuse links that meet EEI-NEMA standards and are said to have accurate time-current characteristics has been announced.

(*Continued on page* 200)

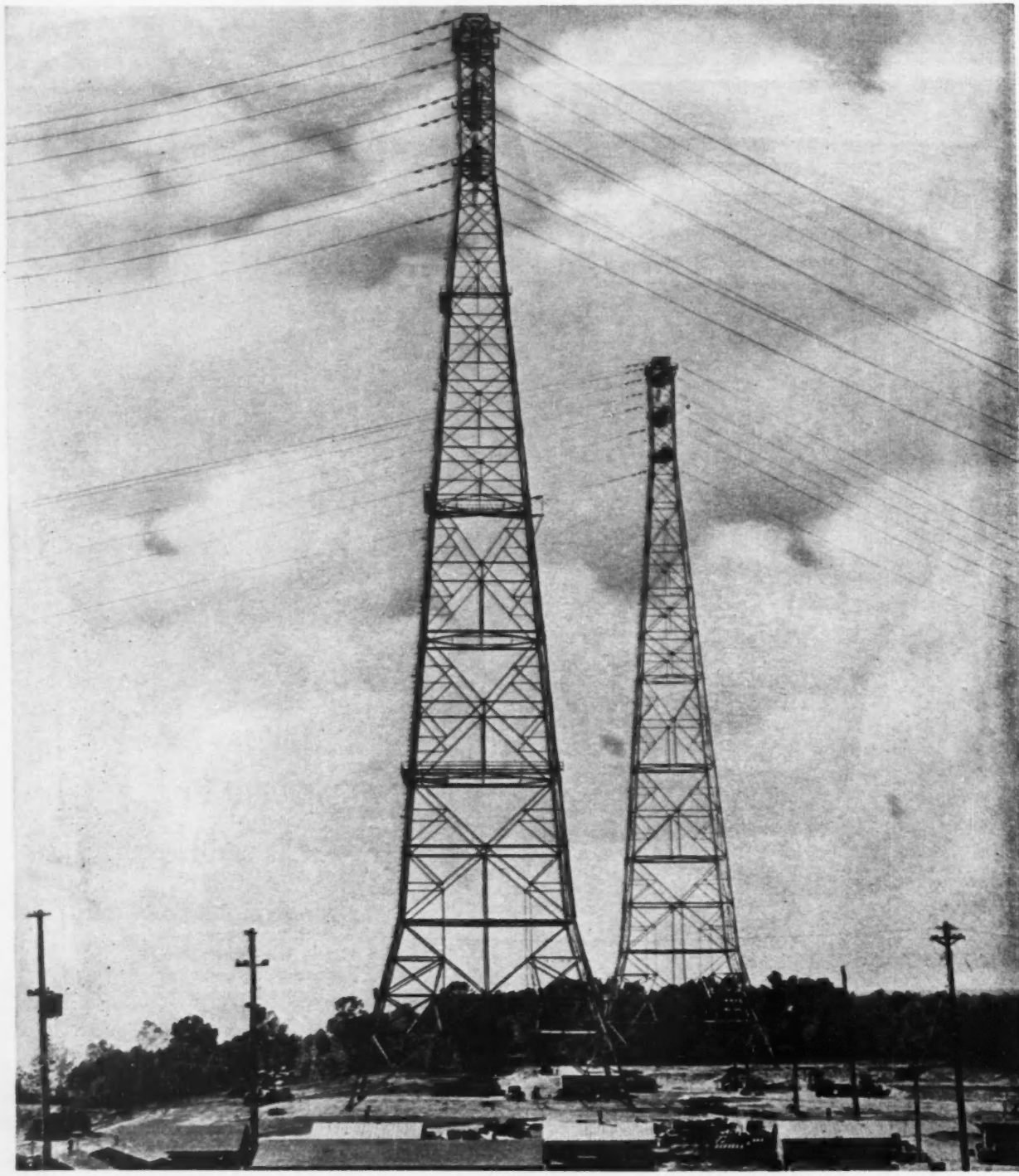


Your Switchboard to Precision Data

● For temperature, batch weighing, force and other measurements . . . investigate the Speedomax Model D Indicator. It gives you more points than any other *one* instrument. Write today for Folder ND46(4), Leeds & Northrup Company, 4938 Stenton Avenue, Philadelphia 44, Pa.

Jrl Ad ND46 (12)

Power for the



The 478 foot Suspension Towers carry four circuits. Note parabolic reflectors and microwave building.

A.E.C.

Power for the Atomic Energy Commission Plant near Paducah, Ky. is supplied by Electric Energy, Inc., drawing from their Joppa, Ill. steam station and from a pool of several large electric utilities.

Four 9-mile transmission lines, constructed in 1952, connect the Joppa 625,000 KW steam station with the A.E.C. Plant. The lines have a capacity of 250 MVA at 161 KV.

The long span Ohio River crossing required high strength conductors plus groundwires suspended on 478 foot river bank towers and dead-ended on adjacent landside towers. Insurance against line failure and power interruptions was of vital importance.

With the cooperation of Ebasco Services Inc. the river crossing Suspension Clamps, Yoke Sets and Dead End Fittings were designed and supplied by BTC.

River Span: 4,400 feet, 8,000 lbs. tension.
Landside Span: 700 feet, 15,000 lbs. tension.

CONDUCTORS

1,061,000 CM A.C.S.R. Stranded 54 x 19. Tapered Armor Rods. Overall Diameter 2.22".

SUSPENSION Specially designed "Trunnion Type" Aluminum Clamps, supported by three strings of insulators and Triple Yoke Sets. Strength of Suspension assemblies is 75,000 lbs. without distortion.

DEAD END Compression Dead End coupled to Triple Yoke Sets. Strength 75,000 lbs. is without distortion.

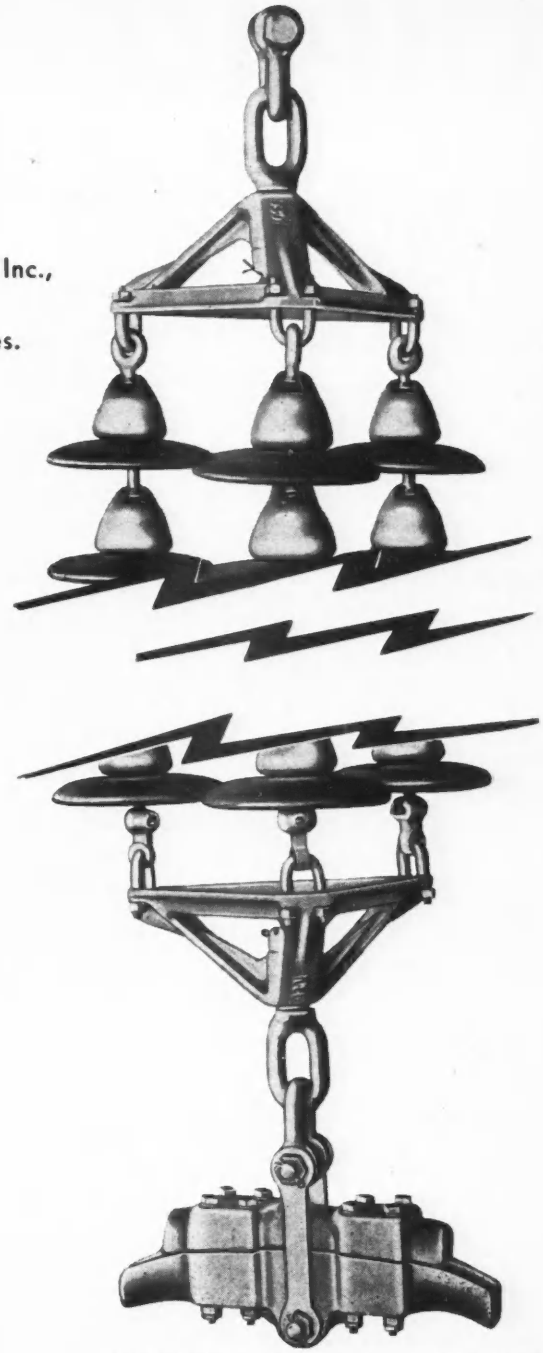
GROUND WIRES

265,000 CM A.C.S.R. Stranded 18 x 19. Tapered Armor Rods. Overall Diameter 1.60".

SUSPENSION Specially designed "Trunnion Type" Aluminum Clamps with Forged Steel Shackle. Strength 75,000 lbs. without distortion.

DEAD END Compression Dead End with two Forged Steel Shackles and Special Link. Strength 75,000 lbs. without distortion.

Sold Through Your Insulator Manufacturer Only



TRIPLE YOKE SET and massive 22 inch length Special Aluminum Suspension Clamp, designed on the "Trunnion" Principle, utilized Forged Steel Side Arm Links and Shackles with high strength bolts to take the total suspension load. Strength 75,000 lbs. without distortion.

Drop Forged* BTC *Hi-Line Hardware

The BREWER-TITCHENER *Corporation*

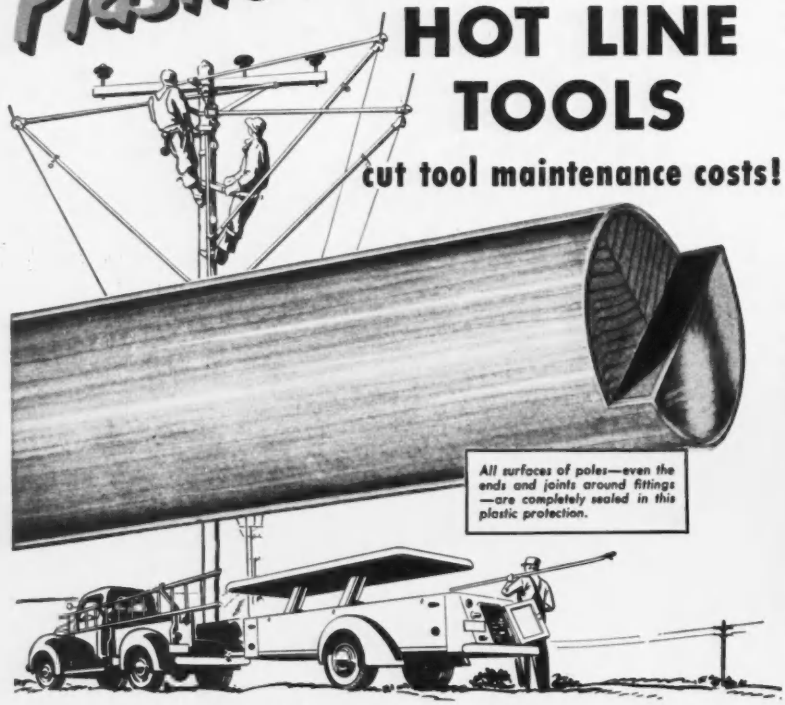
Cortland · New York

CHANCE

MAPLAC*

Plastic Protected HOT LINE TOOLS

cut tool maintenance costs!



Now, Chance lightweight, aluminum-fitted Hot Line Tools are protected with a new super-tough plastic finish called "Maplac"* that greatly reduces tool maintenance and helps to keep tools in safe working condition.

This new plastic protection has many plus features of real value to hot stick users:

TOUGHNESS to withstand any impact or abrasive action encountered in normal use.

TRANSPARENCY that permits initial inspection and periodic checks.

MECHANICAL STRENGTH–Chance "Maplac," being extremely tough, does not require sacrifice of pole size and strength to gain the necessary thickness. It adheres to the wood surface and reinforces the pole adding to the factor of safety.

TEMPERATURE RESISTANCE–retains its toughness under widely varying temperatures.

ELECTRICAL RESISTIVITY– exceeds the voltage withstand tests of the wood insulation (complete safety, however, depends on the moisture content of the wood–no plastic will completely prevent absorption of moisture vapor).

MOISTURE RESISTANCE–Chance "Maplac" retards the absorption of atmospheric vapor in high humidity and protects the wood from precipitation moisture (this does not mean that plastic covered poles are recommended for use in the rain–but that Chance "Maplac" greatly reduces moisture penetration.

REPAIRABILITY–may be repaired without heat or special tools if cut by a sharp blow.

All this at NO INCREASE IN PRICE! Specify Chance "Maplac" Plastic Protected Tools.

* TRADE NAME

C52-4B

ABC INDUSTRIES

A·B·CHANCE CO·

CENTRALIA, MISSOURI

SAN FRANCISCO, CALIF.

New Equipment

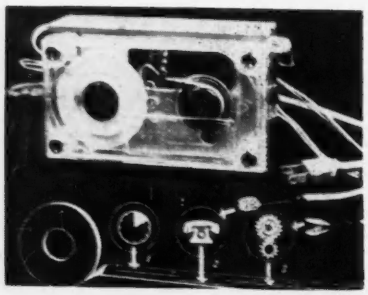
(*Continued from page* 196)

They are available in two speeds, "K" (fast) and "T" (slow), and in ratings from 1 through 200 amp with either wire or die-cast fusible sections.

Die-cast fusible elements are made for links rated 20 through 100 amp. Links from 6 to 20 amp are constructed with hard-drawn pure tin wire fusible elements. On links above 100 amp the fusible element is lap soldered to the shank and ferrule, and the strain wire is securely fastened to relieve all tension on the fusible section.

A fiber protector tube is used on links below 50 amp. Button and shank of the links is a one-piece forging and are coated with tin.

Line Material Co, Milwaukee 1, Wis.



Recorder

For recording time-rate history, the recorder prints and stores two separate data traces plus a timing trace on a Alfax electrosensitive paper. Normally-open or normally-closed switches, attached to phenomena to be monitored, are connected to recorder, which is supplied by 110 v. As switches make and break the marking current passing through tape also stops and starts.

Tape speeds can be adjusted. Actions separated by 1/6-sec duration are said to be recorded.

Alden Electronic and Impulse Recording Equipment Co. Westboro, Mass.

Post Insulators

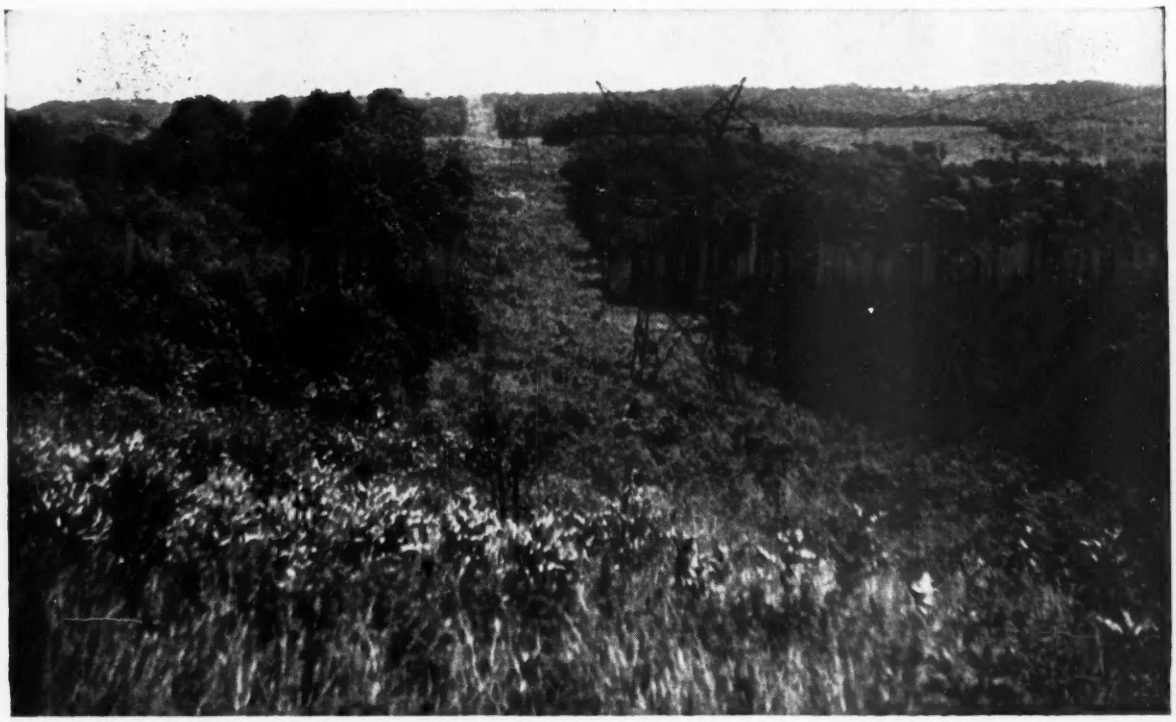
A line of clamp-top line post insulators has been introduced that feature a new clamp-top conductor tie externally bonded on a standard fog-type insulator, to prevent destructive forces. Conductor tie is available with four interchangeable clamps, in

(*Continued on page* 204)

DOW

DOW BRUSH KILLERS CAN CUT CLEARING COSTS 25% TO 50%

Spraying brush and trees with ESTERON BRUSH KILLER and ESTERON 245 gives better control than cutting



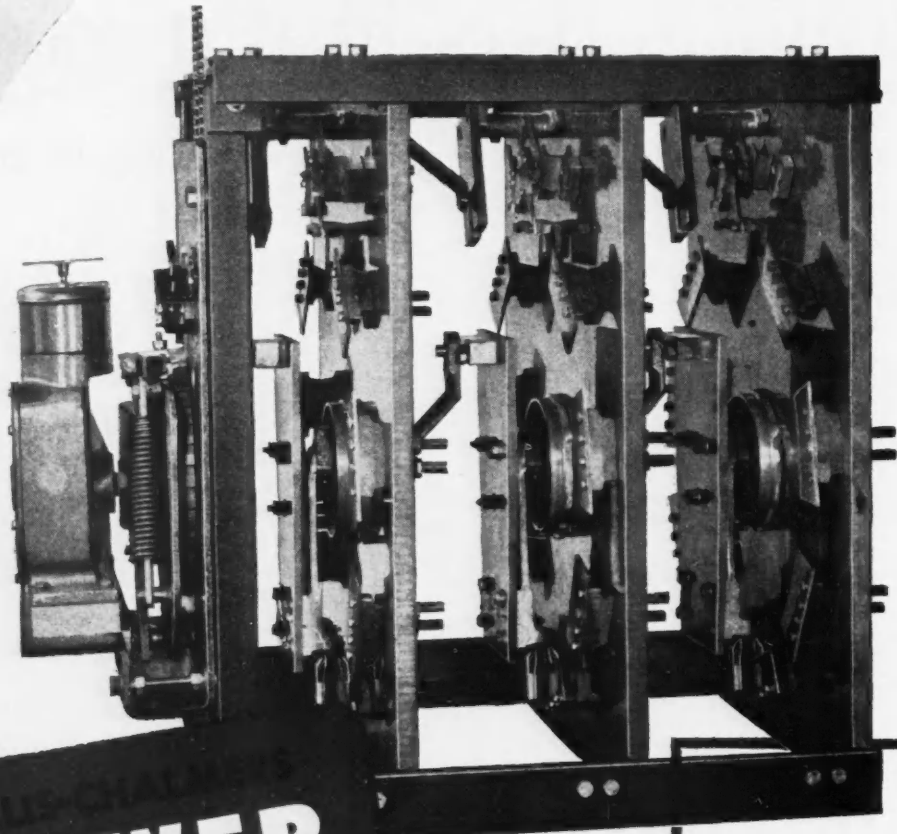
Clearing the way for the nation's power and communication lines is a job which calls for Dow's hard-hitting, result-getting brush killers—Esteron® Brush Killer and Esteron® 245. Both products are adapted to the three recognized methods of brush control: (1) foliage, (2) basal bark and (3) stump treatment. Both contain highly effective, low-volatility propylene glycol butyl ether esters which have been used successfully on thousands of miles of right-of-way.

Esteron Brush Killer, a mixture of 2,4-D and 2,4,5-T esters, is widely used for spraying mixed stands of brush in leaf. Use Esteron 245 for certain 2,4-D-resistant species like poison ivy. It can be used as a water spray on foliage and in oil for year-around basal bark and stump treatment.

For tough weeds—Esteron® Ten-Ten, a new Dow low-volatility 2,4-D ester product, has shown great progress in weed control. For unwanted grass—use Dow Sodium TCA 90%, alone or in combination with Dow weed and brush killers. You are invited to call on Dow sales and technical men for assistance in planning your right-of-way clearance and maintenance programs. THE DOW CHEMICAL COMPANY, *Agricultural Chemical Department*, Midland, Michigan. In Canada: Dow Chemical of Canada, Limited, Toronto, Canada.

you can depend on DOW AGRICULTURAL CHEMICALS DOW

20 Years'



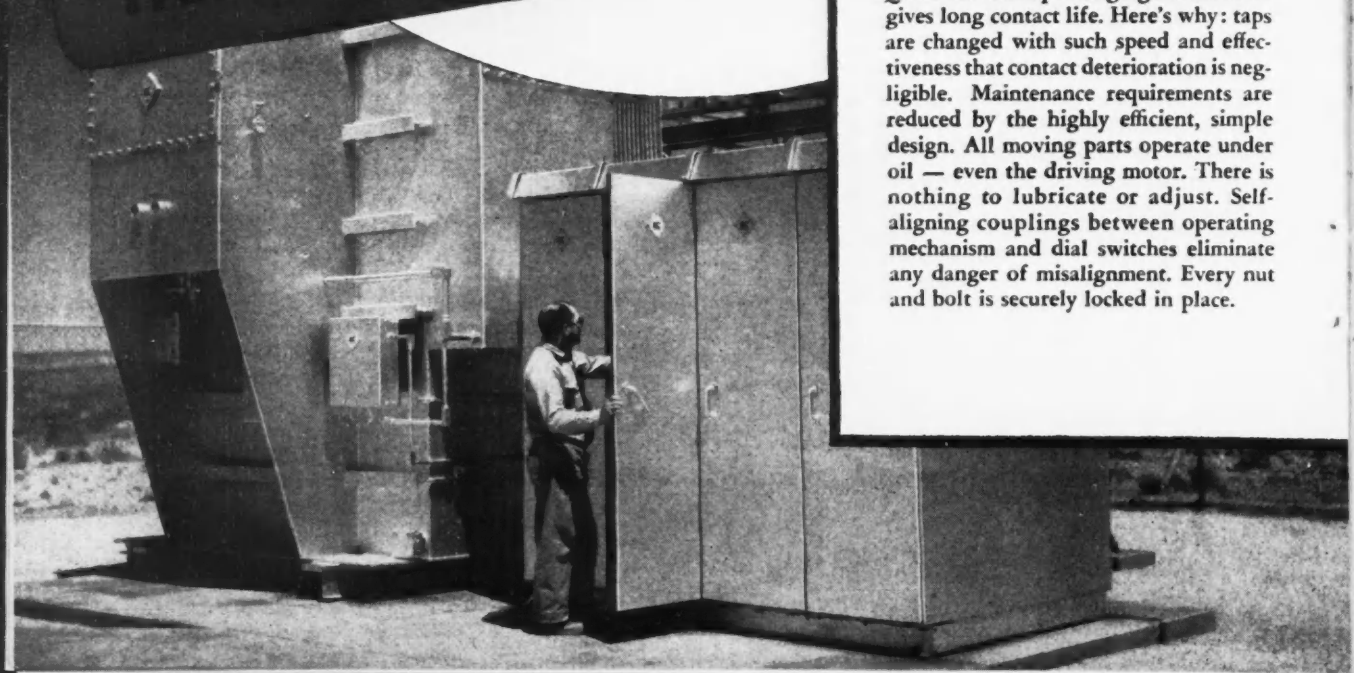
ALLIS-CHALMERS

POWER

Transformers

Simple, Rugged Design

Quick-Break tap-changing mechanism gives long contact life. Here's why: taps are changed with such speed and effectiveness that contact deterioration is negligible. Maintenance requirements are reduced by the highly efficient, simple design. All moving parts operate under oil — even the driving motor. There is nothing to lubricate or adjust. Self-aligning couplings between operating mechanism and dial switches eliminate any danger of misalignment. Every nut and bolt is securely locked in place.



Field Proof-

Here's the Tap-Changing-Under-Load Mechanism That Has Given 20 Years of Unequalled Performance

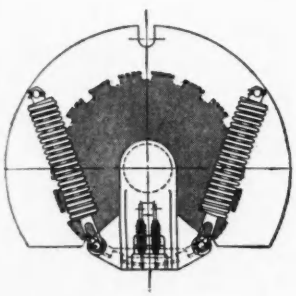
Field-proved — and unsurpassed in twenty years — that's the story behind Allis-Chalmers famous *Quick-Break* tap-changing mechanism. No other tap changer on the market gives you its combination of ruggedness, accuracy, and simplicity — features that add up to practically trouble-free operation.

Laboratory-proved — tests show that the *Quick-Break* mechanism will withstand 5 million operations — equivalent to over one hundred years of normal service. The *Quick-Break* mechanism was designed to operate under the most difficult conditions. After twenty years of field operation, it is still the simplest, most efficient means of changing taps under load.

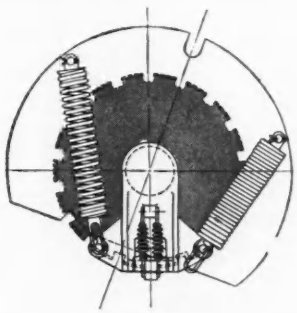
Get More Facts. If you don't have all the facts already, it will pay you to get more details by contacting your nearby Allis-Chalmers office or writing Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4127

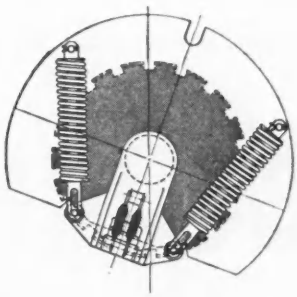
How It Works



1 Dial switch operates on the balanced spring principle. Components include outer moving segment, inner stationary index plate, and powerful springs for fast drive snubbing action.



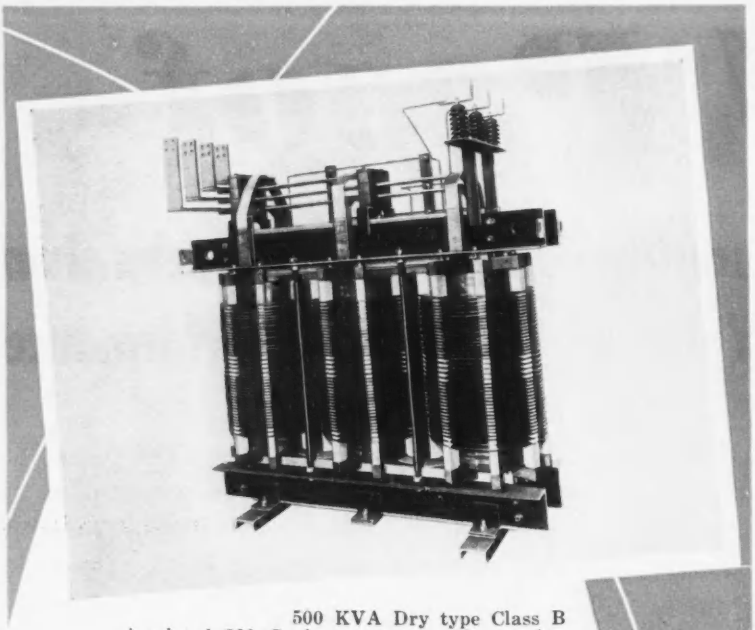
2 Start: driving motor rotates outer segment but latch on crank arm holds tap switch in position. Heavy-duty springs store energy to produce quick start and stop of switch.



3 Finish: cam on segment lifts latch. Released spring tension rotates switch swiftly to next operating position. Latch locks switch and places mechanism in position for next change.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS



500 KVA Dry type Class B insulated 80° C rise core and coil assembly 13800 V Delta to 208 Y/120

EVERY STOCKWELL TRANSFORMER is the result of specialized research and sound design. Rigidly controlled materials and modern production facilities are additional guarantees of the quality of our products.

Our field organization and our staff of application engineers at Akron will be glad to help you on all your transformer and substation problems.

STOCKWELL

TRANSFORMERS

DESIGNED FOR YOUR REQUIREMENTS

STOCKWELL TRANSFORMER CORP.

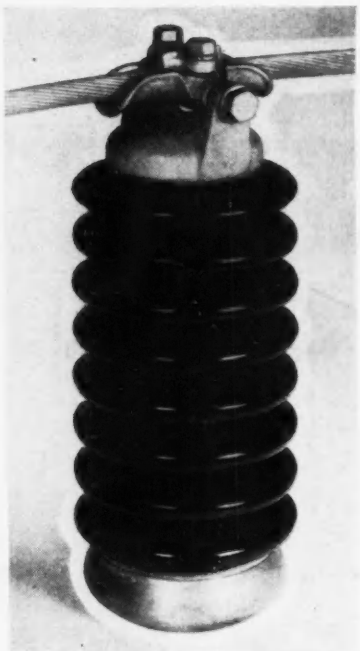
AKRON, OHIO

OIL-FILLED, DRY TYPE, and ASKAREL-FILLED DISTRIBUTION AND POWER TRANSFORMERS

3-1

New Equipment

(*Continued from page* 200)



ferrous or aluminum, for conductor diameters from 0.25 to 1.50 in.

To change a clamp it is only necessary to back off one cap screw that forms one end of trunnion bearing and clamp can be lifted out of position. Eight voltage ratings from 20 to 88 kv are available in the line.

Lapp Insulator Co, Inc, Le Roy, N. Y.

Fault Finder

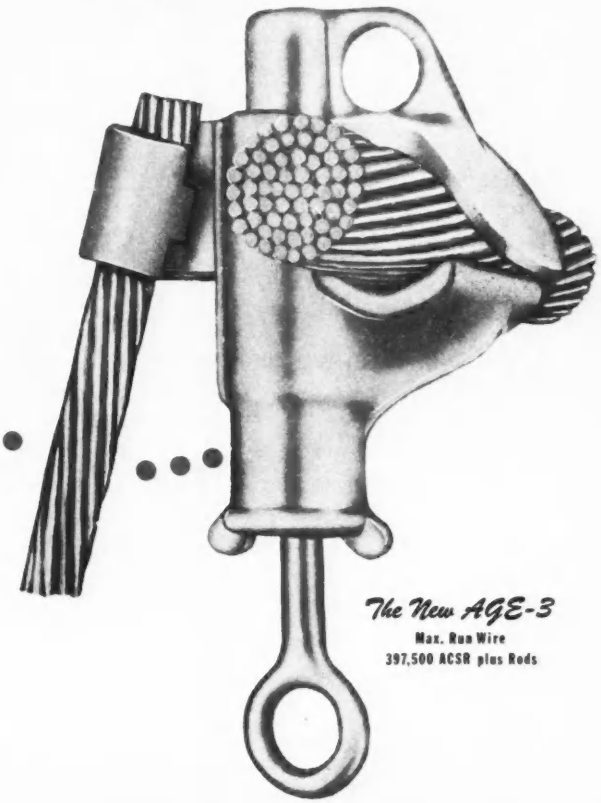
A light-weight cable fault finder for locating open circuits or low and high resistance shorts, of 10,000 ohms or less, for rubber, neoprene, thermo

(*Continued on page* 208)

Four of a Kind

FARGO HOT LINE CLAMPS

all have husky springs...



The New AGE-3
Max. Run Wire
397,500 ACSR plus Rods

Fargo now offers the "AGE" spring-loaded clamps in four sizes to meet your hot line clamp requirements. All four have the Fargo designed heavy-duty, vanadium steel, stress annealed spring which gives the clamp better performance and longer service life.

The husky spring compensates for variables caused by fault currents . . . atmospheric changes . . . load variations and the tendency of the conductor to "relax" or "flow" while under stress.

All clamps are immersed in a corrosion inhibiting grease for the added protection of the clamp. They are individually packaged.

Available in aluminum for aluminum or aluminum to copper connections, in bronze for copper connections, and in plated bronze for all-purpose use.

The four clamps cover a range of run conductor sizes from .128″ thru 1.625″.

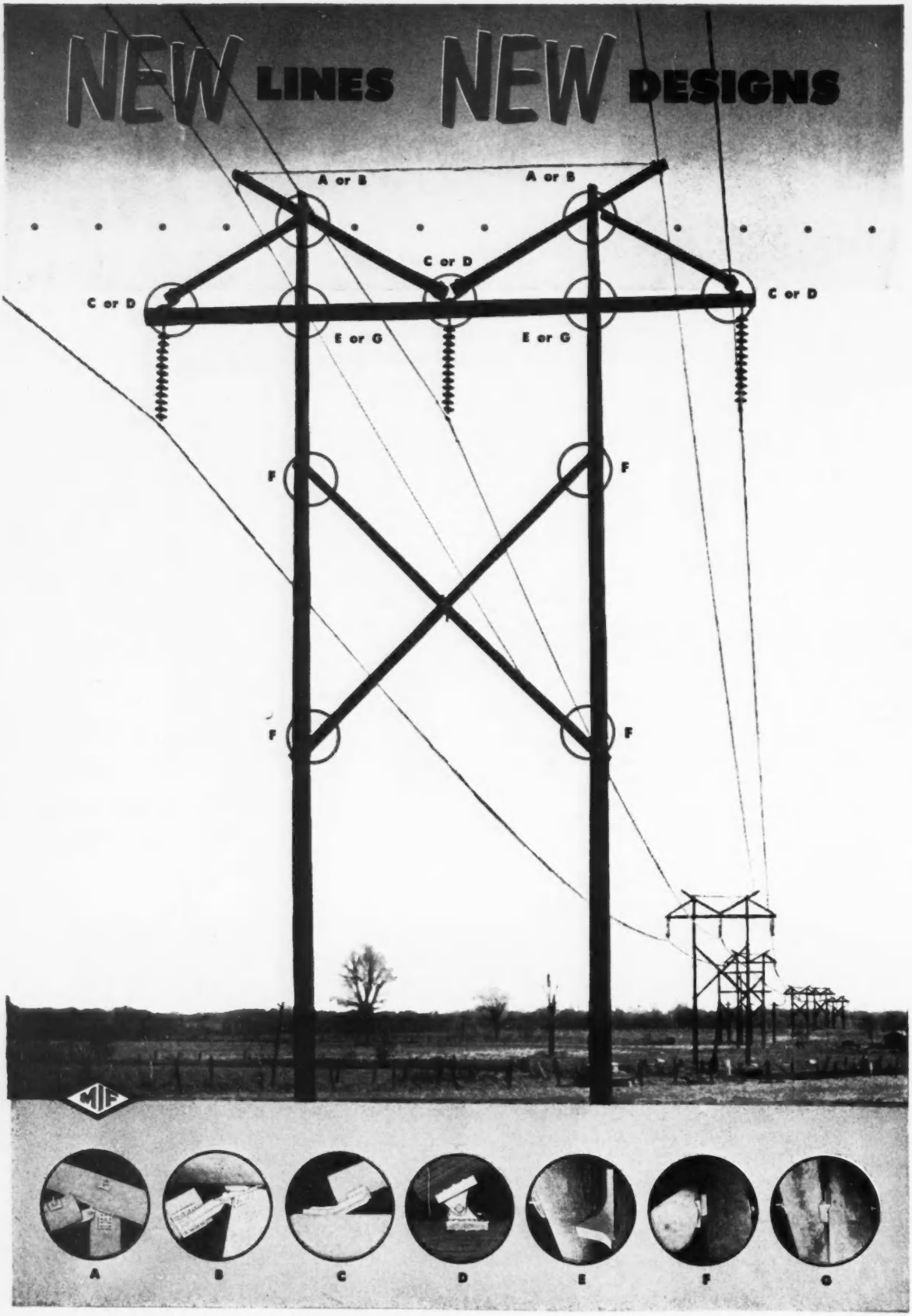
Ask your Line Material Field Engineer for complete details.

FARGO

Manufactured by
FARGO MFG. COMPANY, INC.
Poughkeepsie, N. Y.

Distributed by
LINE MATERIAL COMPANY
(A McGraw Electric Company Division)
Milwaukee, Wisconsin

LM®


NEW LINES NEW DESIGNS
A or B
A or B
C or D
C or D
C or D
E or G
E or G
F
F
F
F
A
B
C
D
E
F
G

NEW

MIF

GRID GAINS

Tests show that forces can be transferred through the Grid Gain which are from four to five times those which can be resisted by a bolt without the Gain.

Reduces field drilling to a minimum.

Eliminates gaining and notching.
Reduces number of bolts and therefore number of holes in the various members.
Single bolt adequate for most connections.

Simplifies and speeds up assembly. Lower initial cost.

M.I.F. Grid Gains are the basic hardware around which M.I.F. framing hardware is designed. By increasing the bearing value of the through bolt, Grid Gains increase the shear value of connections.

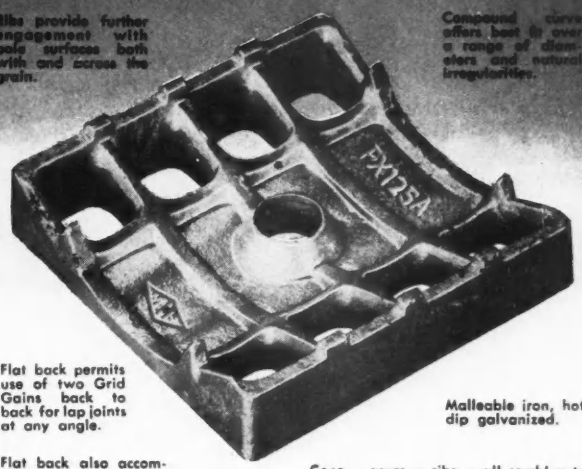
Because they permit lap and butt joints to be made at any angle and with a minimum of accessory hardware, M.I.F. Grid Gains offer many new possibilities to designers in the framing of relatively complex, as well as simple, structures out of round members.

Cone increases the effective projected area of the through bolt.

Spurs penetrate and add stability.

Ribs provide further engagement with pole surface both with and across the grain.

Compound curve offers best fit over a range of diameters and natural irregularities.

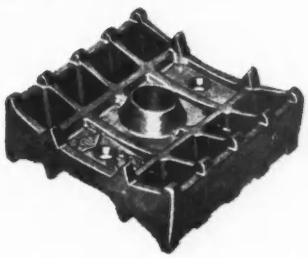


Flat back permits use of two Grid Gains back to back for lap joints at any angle.

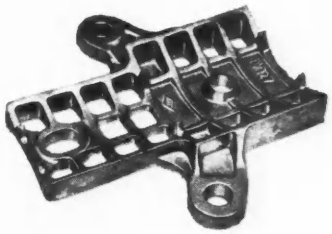
Malleable iron, hot dip galvanized.

Flat back also accommodates intermediate connecting fittings for butt joints or dead end connections.

Cone — spurs — ribs — all combine to provide maximum effective bearing or contact between Grid Gain and wood.



DOUBLE GRID GAIN
For stubbing, pole top extensions, splicing, securing poles to pile clusters.



GRID GAIN WITH SIDE EYES
Typical modification of basic Gain for making both lap and butt joints simultaneously.

★ WRITE FOR BULLETIN PH10

MALLEABLE IRON FITTINGS CO.

Pole Hardware Division — **Branford, Connecticut**

N. Y. Office: 30 Church St. • Canadian Mfr. & Dist.: Line & Cable Accessories, Ltd. Toronto

MIF

Representatives: William J. Cottrell Co., Portland, Ore. • James H. Drew Corp., Indianapolis, Ind. • Industrial Engr. & Equip. Corp., Los Angeles, Cal. • JSG Electric Co., Chicago, Ill. • B. H. McCain, Knoxville, Tenn. • E. A. Thornwell, Inc., Atlanta, Georgia • J. P. Voight, Summerville, S. C. • Waltham, DeWitt & Krust, San Francisco, Calif. • L. G. Wendegatz, Kansas City, Mo. • Williams Sales Co., Fort Myers, Fla. • Williamson Sales Co., Shreveport, La. • O. C. Witte Co., Detroit, Mich.

The Model RG is now available in 1,500- and 3,000-lb. capacities—other sizes will follow.

Advanced Guard for a New, Advanced Line

Here is a completely new ratchet lever hoist designed to bring you added safety and convenience. The Model RG incorporates the time-proved ratchet and pawl principle originated by Coffing — makes it hold positively at all times — no friction-type brake to slip or freeze—chain is free wheeling when not under load.

Many New Advantages

COIL CHAIN Swings or wraps in any direction for greater flexibility in use.

SIX OPERATING POSITIONS Handle operates in any position, works on full or partial strokes — for ease of handling in close quarters. Safety stops prevent spinning of handle.

BIG SAFETY FACTOR For your protection the Model RG has 100 percent overload safety factor, although the warranty covers only up to rated capacity. "Safety-valve" handle bends at point of maximum safe overload.

SIMPLE TO SERVICE The Model RG may be completely disassembled with only a screwdriver for easy servicing. Not necessary to return it to the factory for repairs.

Find out more about the hoist that gives you greater convenience and safety in all lifting, pulling, stretching. Write for Bulletin E8R.

COFFING HOIST COMPANY
Danville, Illinois

Quik-Lift Electric Hoists • Hoist-Alls • Load Binders
Mighty-Midget Pullers • Spur-Geared Hoists
Differential Chain Hoists • I-Beam Trolleys

Sold by Industrial Distributors everywhere

New Equipment

(*Continued from page* 204)

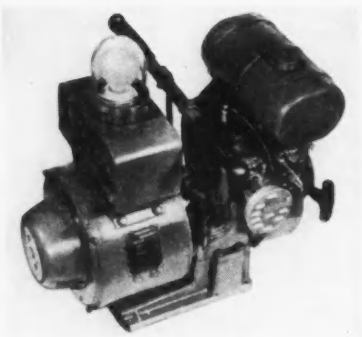
plastic, or similar jacketed cables has been announced. In use, signal generated by the transmitter creates a magnetic or static field around cable being tested. The receiver picks up this field through it probe and converts it into an audible sound in the earphone.

Both transmitter and receiver are powered by standard dry cells. Manufacturer states that this unit is ruggedly constructed, simple to operate.
Joy Manufacturing Co, Pittsburgh 22.

Shielded Enclosures

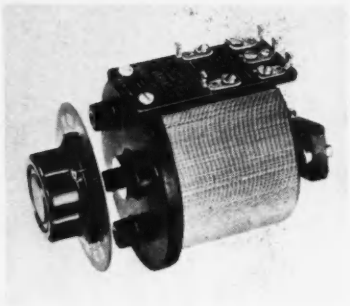
A complete new line of galvanized single-shielded enclosures for suppressing radio-frequency radiations of induction heating equipment, etc, is available. The screened enclosures are said to provide more than 40-db attenuation from 14 kc to 400 Mc. Up to 66-db attenuation at standard VHF TV frequencies can be expected.

Enclosures consist of a number of standard size panels rigidly bolted together from the inside. Each panel is a framework of kiln-dried, select white pine covered with a single layer of 22-mesh galvanized steel screen. Floors are ¾-in. plywood, with a loading capacity of 300 lb per ft.
Ace Engineering & Machine Co, Philadelphia 40, Pa.



Power Plant

The gasoline engine-generator sets are available in two models. Model 119 is a 1.5-kw, 115-v, dc unit, having a 3-hp, single-cylinder engine, four outlets, and weighs 75 lb. Model 118 is similar to the 119 except it provides an ac source and weighs 135 lb.
Porter-Cable Machine Co, Syracuse, N. Y.



Autotransformer

The V-line Variac is being supplied with a Duratrak brush-track surface. This silver alloy coating applied to the brush track is said to prevent contact surface deterioration. Type V-2 is rated at 2 amp.
General Radio Co, Cambridge 39, Mass.

MORE NEW PRODUCTS
about which you should know

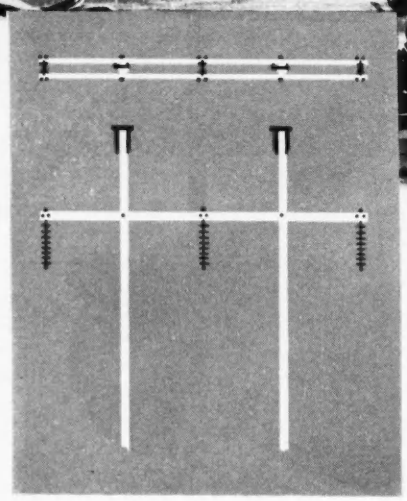
The George W. Borg Corp, Janesville, Wis., announces friction-locked ten-turn **counting dial** for use on the company's potentiometer . . . General Electric Co, Schenectady 5, N. Y., has a synthetic rubber **insulation** that replaces fiber in brush mechanisms for dc equipment.

Daven Co, Newark, N. J., announces a printed circuit **rotary switch** with 60 positions and shorting-type action. A switch having 30 nonshorting positions is also available . . . Electronic Rectifier Co, Rochester, N. Y., has a three-phase, twenty-five-amp **rectifier.**

Cleveland Process Co, Cleveland, Ohio, announces a heavy duty steel sheathed **immersion heater** for alkaline bath heating, rated at 230 and 460 v, from 1,000 to 10,000 w . . . Sun Chemical Corp, Long Island City 1, N. Y., has a layer and **phase insulation** said to have high dielectric and mechanical strength. It is available in 0.01 and 0.012 in.

Victory Engineering Corporation, Union, N. J., has a portable electric **combustion analyzer** that measures CO_2, temperature and draft . . . Min-

(*Continued on page* 217)



Type No. 700
Tangent Structure
for voltages 69 to 154 KV*

LIST OF MATERIAL

Quantity	Description
2	Crossarm
3	Steel spacer fitting w/mounting bolts
2	Stud bolt ⅞" w/2 washer nuts
4	MF locknut ⅞"
2	Static wire support
4	Machine bolt ⅝" w/locknut
2	Clevis
2	Suspension clamp for static wire
as req'd	Suspension insulator and fitting

**This print was reproduced from the Graybar Bulletin GB-5076A on High Voltage Transmission Line Materials. This 92-page book covers, in condensed form, Graybar materials for line construction. Write us, if you do not already have your free copy.*

Transmission lines do come as "packages"— via Graybar

One source . . . one responsibility for all your transmission line needs.

Crossarms, poles, hardware . . . on the job . . . on schedule . . . prebored and prefitted to your own specifications — that's how line structures come as "packages" via Graybar.

Investigate this service, today. We can deliver completely assembled crossarms for any structure you design — fabricating and boring of the arms completed and hardware attached.

The result? A better structure planned and built to fit your "specs." And, as a bonus — less procurement paperwork . . . less follow-up than with multiple sources of supply.

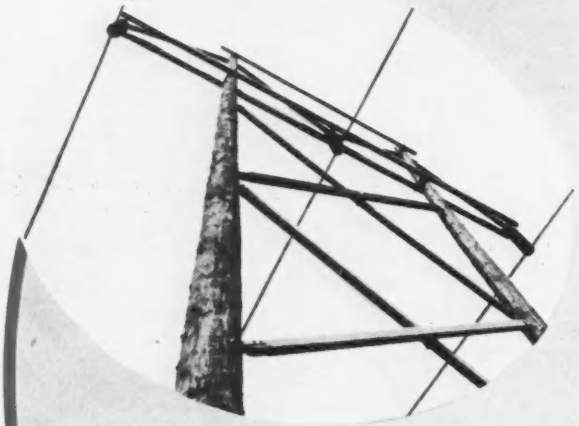
For complete details contact your local Graybar Representative — he'll be glad to work with your staff. *Graybar Electric Company, Inc. Executive Offices: Graybar Building, 420 Lexington Avenue, New York 17, N. Y.* 364-98

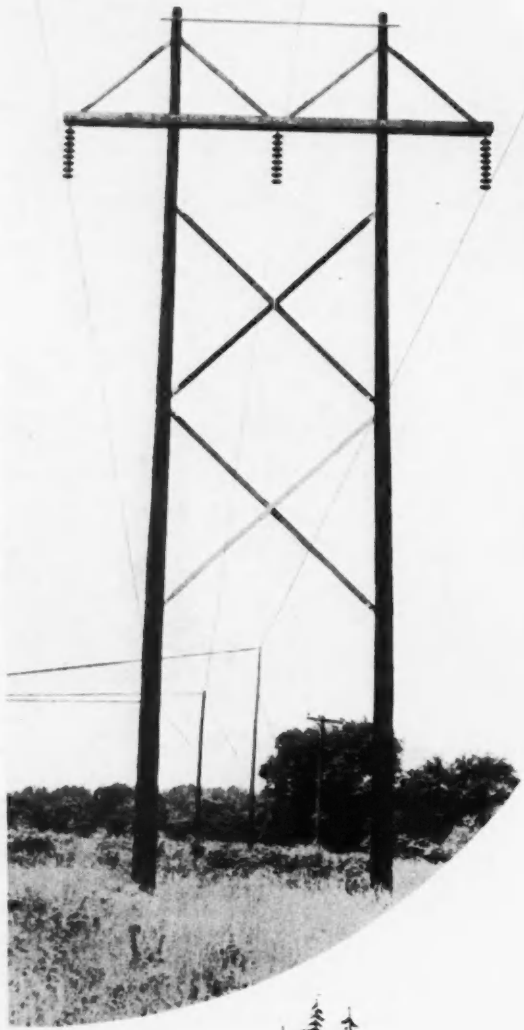
CALL GRAYBAR FIRST FOR...

IN OVER 100 PRINCIPAL CITIES

RAINIER
WOOD PRODUCTS
TRADE MARK

ALL WOOD TRANSMISSION LINES





RANIER TRANSMISSION ARMS are increasingly in demand for high voltage transmission line construction. A popular labor-saving service is the delivery of crossarm assemblies as a package, with all necessary hardware attached.

•

RANIER WOOD CROSSARM, X, VEE, and KNEE BRACES provide important economies as labor costs rise. The braces are designed for easy installation, and are available in all standard sizes from strategically located factories.

RANIER CROSSARMS are a standard of the utility industry. Proper selection of raw material, thorough conditioning, and accurate production control assure long years of service.

Factories:

Chehalis, Wash. — Kansas City, Mo. — Chicago, Ill.
Texarkana, Texas — Danville, Pa. — Minneapolis, Minn.

AMERICAN CROSSARM AND CONDUIT COMPANY

RAINIER WOOD PRODUCTS TRADE MARK

General Offices: **7726 Sheridan Road, Chicago 26, Ill.**

Sales Offices:
Minneapolis, Minn. — Kansas City, Mo. — Texarkana, Texas — Chehalis, Wash — Danville, Pa.

Everything for transmission lines... *via* GraybaR

CHANCE Plate Anchors

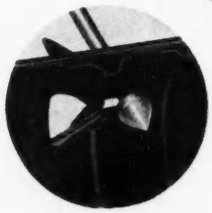
Speed Transmission Guying

...SAVE MAN HOURS—CUT COSTS—HOLD GREATER LOADS

CHANCE NEVER-CREEP ANCHORS

You gain two ways when you choose Never-Creep Anchors for guying transmission or heavy distribution lines. First, they can be installed in machine bored holes because the size of the hole makes no difference in the holding power of the Never-Creep. Second, these anchors pull entirely against solid, undisturbed earth because the hole is at an angle away from the guy.

Never-Creep anchor plates are formed of high strength structural steel and are reinforced in the area of greatest pull with a high carbon steel core plate and the socket or "rod lock" plate which has reinforcing ribs. Dual-purpose creep guards keep the anchor from creeping up the hole and guide the rod point into the socket.



Circle shows reinforcing plate and rod socket.

CHANCE CROSS-PLATE ANCHORS

The Chance Cross-Plate Anchor helps speed up big line construction jobs. It replaces improvised "dead-men" and can be installed in slanted or vertical machine bored holes in any kind of soil. This all-steel anchor compares in cost with an average 4 foot treated log.

Laboratory tests on a Chance X-24 Cross-Plate proved it capable of indefinitely withstanding a pull of 70,000 lbs. with only slight bending, while a creosoted log split under a 20,000 lb. pull in a few hours.

Nut retainer aids installation.

You know it's RIGHT when you specify CHANCE

A·B·CHANCE CO·

CENTRALIA, MISSOURI
SAN FRANCISCO, CALIFORNIA

ANCHORS • GUYING FIXTURES • LINE CONSTRUCTION TOOLS • CONDUCTOR CLAMPS
GROUNDING EQUIPMENT • HOT LINE TOOLS • HIGH VOLTAGE SWITCHES • CUTOUTS

FIND OUT WHY!

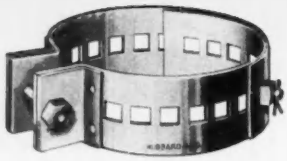
It's wise to use Chance Anchors instead of "dead-man" logs or slugs. Write today for test records and actual cost comparisons. We'll send you reasons why your next transmission line should be guyed the stronger, low-cost way — with CHANCE Anchors.

Everything for transmission lines... *via* GraybaR

NO. 29816 MACHINE BOLT

NO. 29716 STUD BOLT

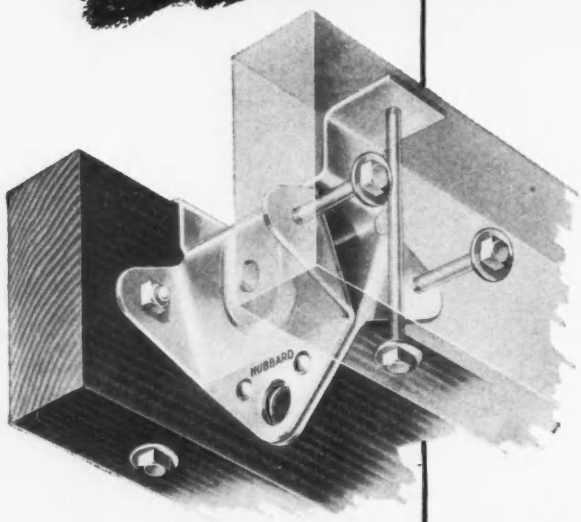
Machine Bolts—Stud Bolts—to ⅞-inch Diam. for all types of Wood Structures



NO. 7277 POLE BAND

Complete Line of Bands with Accessories and Attachments—adjustable and solid.

A FEW OF THE MANY HUBBARD PRODUCTS FOR HIGH VOLTAGE *Transmission Lines*



NO. 5820 SPACER FITTING

A most popular style for Vee Brace attachment. Spaces and reinforces double plank construction. Threaded bolt holes for static free assembly. All welded construction.

NAME THE LOAD ON HUBBARD HARDWARE

Everything for transmission lines... *via* GraybaR

NO. 7011 SERIES FOUR WAY WOOD STRAIN INSULATORS

The only wood strain that holds to the breaking strength of the wood. Unique design eliminates tendency of fittings to "shear out" under excessive loading.

HUBBARD AND COMPANY
ESTABLISHED 1843
PITTSBURGH • CHICAGO • OAKLAND, CALIFORNIA
"Hang the Load on Hubbard Hardware!"

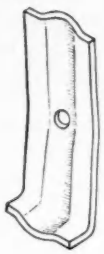
HUBBARD-COPPERWELD GROUND RODS

All sizes—solid and sectional for permanent, low resistance grounds. Each Hubbard Copperweld Ground Rod is stamped near the top with a numeral designating length of rod.

HUBBARD-COPPERWELD GROUND ROD CLAMPS

For permanent connections—Safety Set Screw and Square Head Bolt types

Cross section of a ½-inch Copperweld Ground Rod showing approximate proportion of copper and steel



TIE PLATES AND GAIN PLATES

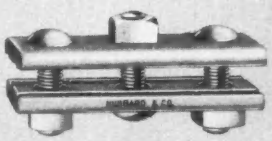
Many styles and sizes

SHACKLES

All sizes and styles

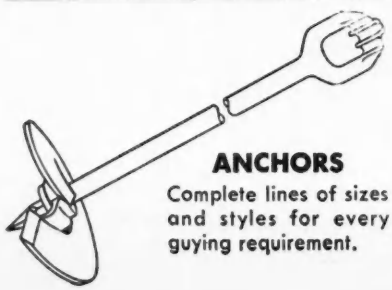
SPRING CLIP WASHERS

Full line of static free hardware



GUY CLAMPS

Complete range of clamps and clips for all sizes of guys.



ANCHORS

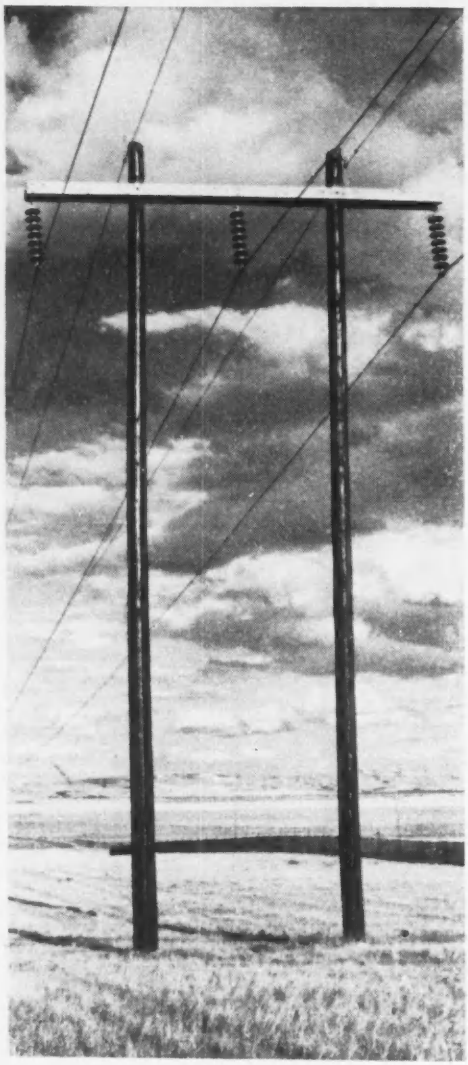
Complete lines of sizes and styles for every guying requirement.

SWINGING BRACKETS

Angle Brackets and accessories

Everything for transmission lines... via GraybaR

DEPENDABLE



Poles

of

Selected Sound Timber Scientifically Treated

THE lasting strength of International Creosoted Pine Poles plus their low ultimate cost makes them the safest and most economical poles that can be purchased. For more than 75 years, numerous service records of pole treatments have been utilized to perfect the present production practices for International Creosoted Poles. As a result of the lessons learned during this long experience, International Creosoted Poles will assure trouble-free, continuous service. Their straight, clean, smooth surfaces perfectly adapt them for street lighting, rural and urban distribution.

International Creosoted Pine Poles are manufactured and distributed by two of the oldest companies serving the utility industry. They have grown up together, ready always to serve with quality poles, framed correctly, and shipped when needed.

GraybaR Distributed by GraybaR Electric Company

INTERNATIONAL CREOSOTING & CONSTRUCTION CO.

PRODUCERS OF HIGH GRADE TREATED TIES, POLES, PILES, ETC.

Galveston — Beaumont — Texarkana

Everything for transmission lines... via GraybaR

Crapo Steel Strand

For Guys, Messenger and Overhead Ground Wire, Specify *Crapo* Strand!

Strength, ruggedness, workability, long-life are combined — with all-important **economy** — in *Crapo* Galvanized Steel Strand.

The superior tensile strength of the steel is utilized to fullest advantage in each size and grade. The heavy, ductile, tightly-adherent galvanized zinc coating — applied by the famous *Crapo* Process — provides dependable protection for the steel, prolongs the life of the strand.

There is a size and grade of *Crapo* Galvanized Strand for every practical need. Contact the nearest Graybar house or ask the Graybar representative for further information!

INDIANA STEEL & WIRE COMPANY — MUNCIE, INDIANA

PREFORMED ARMOR RODS

Protect and Reinforce Your Conductors at Small Cost

PREFORMED ARMOR RODS provide a **simple, practical, economical** method of reinforcing and protecting overhead conductors and static wires at the point of, and in the region of, the supports.

Accurately designed and preformed to prescribed length and pitch, these spiral rods form a snug-fitting, compact, cylindrical armor over conductor or static wire. Easily and quickly installed by hand. **No clamps or clips** are required.

PREFORMED ARMOR RODS also are being used successfully to repair multi-stranded conductors and to reinforce worn conductors. Produced in Aluminum-Alloy, Galvanized and Stainless Steel, Copperweld and Copper or Bronze. Ask your Graybar representative for details!

INDIANA STEEL & WIRE COMPANY — MUNCIE, INDIANA

Everything for transmission lines... *via* Graybar

New Equipment

(*Continued from page* 208)

neapolis - Honeywell Regulator Co, Freeport, Ill., announces two new series of **toggle switches** having riveted silver contacts, and a copper moving contact carrier.

Penetone Co, Tenafly, N. J., announces a non-inflammable, low-toxicity, **cleaning solvent** that is said to dry in 15 sec . . . Radio Receptor Co, New York 11, N. Y., has a line of **selenium rectifiers** that are encapsulated in a resin and may be operated in temperatures up to 125C.

Livingstone Engineering Co, Worcester 5, Mass., announces a heavy-duty **all-electric jet cleaner** with a steam generator that is self regulating and 98½% efficient . . . H. P. Preis Engraving Machine Co, Hillside, N. J., has a portable **electric marker** for marking all steels.

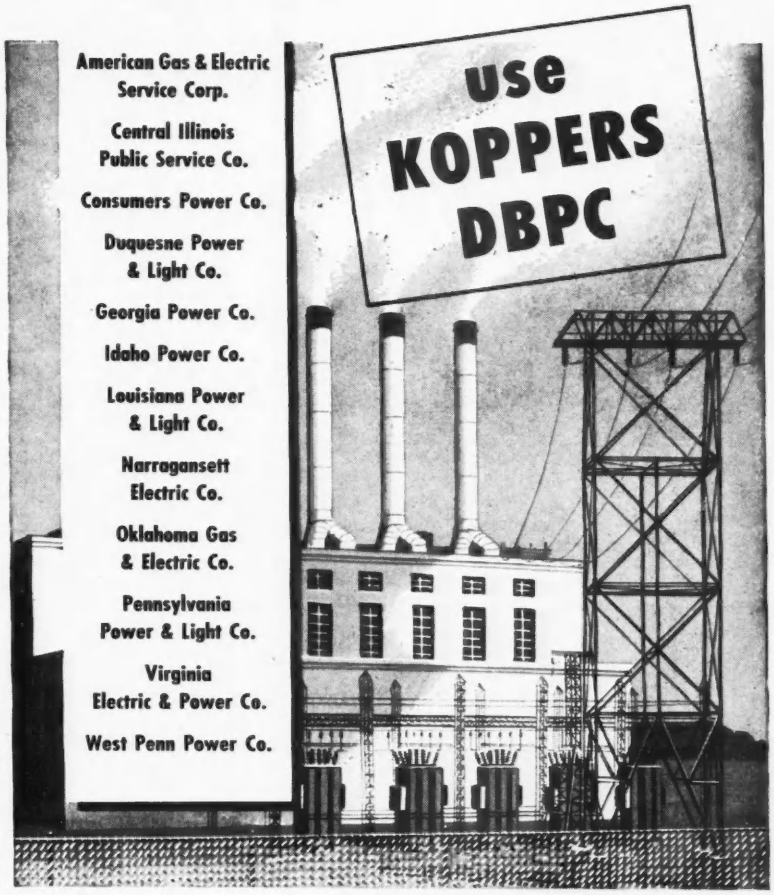
Tomic Sales & Engineering Co, Detroit, Mich., introduces a new **wire stripper** for two and three-wire non-metallic cable, which has tempered steel blades . . . London Chemical Co, Inc, Chicago 16, Ill., has a **rosin flux,** which is non-corrosive, for dip tinning of printed circuits.

K. H. Huppert Co, Chicago 37, Ill., announces a high temperature electric vacuum **furnace,** called the Airfre, for use where temperatures up to 2,500F and vacuums up to 29 in. are required . . . Computed Control Co, Belmont 78, Mass., has a **memory unit,** Model 3C1-384, that stores 384 bits at a pulse repetition rate of 1 Mc.

Tect, Inc, Dumont, N. J., announces a low-toxicity **cleaning solvent,** called Tecsolv No. 383, that is said to be non-inflammable and fast evaporating . . . J. B. Sebrell Corp, Los Angeles 13, Calif., has a **light bulb changer** in sizes 15 to 1,500 w that can be attached to a pole to reach high bulbs.

Federal Electric Products Co, Newark 5, N. J., announces a 200-amp **safety switch** that is front operated to provide space savings . . . Gulton Mfg Co, Metuchen, N. J., has a **capacitance limit bridge** for testing capacitors between 0.0001 and 1 mfd within an accuracy of 0.3%.

Increase transformer oil life like these companies do . . .


American Gas & Electric Service Corp.
Central Illinois Public Service Co.
Consumers Power Co.
Duquesne Power & Light Co.
Georgia Power Co.
Idaho Power Co.
Louisiana Power & Light Co.
Narragansett Electric Co.
Oklahoma Gas & Electric Co.
Pennsylvania Power & Light Co.
Virginia Electric & Power Co.
West Penn Power Co.
use KOPPERS DBPC

HIGH-LOAD TRANSFORMERS require a sludge-free insulating oil. Di-tert-butyl-para-cresol greatly increases the resistance of transformer lubricating oils to oxidation and keeps sludge formation to a minimum. It assures longer oil life and more efficient transformer performance.

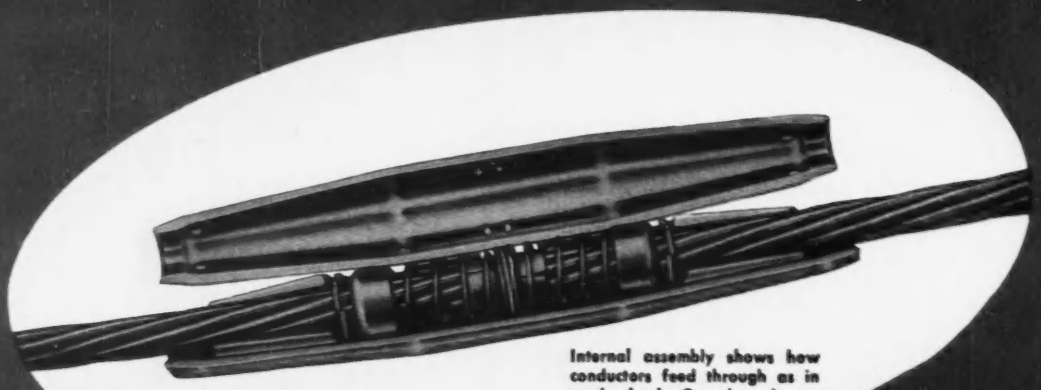
Accelerated oxidation tests have proved that new transformer oil treated with 0.3% of DBPC will last *14 times longer* than untreated oil. Reclaimed oil will last longer, too, when treated with DBPC. Although badly deteriorated and heavily sludged, used oil can be restored by treatment with fuller's earth and DBPC so that it will actually outlast brand new uninhibited oil!

DBPC is also available in an oil solution called IMPRUVOL 20. Either of these inhibitors can be used in transformers and circuit breakers. Write us for additional information.

KOPPERS® **Koppers Chemicals**

KOPPERS COMPANY, INC.
Chemical Division, Dept. EW-8243
Koppers Building, Pittsburgh 19, Pa.

Reliable LIFTS THE LID on a New STRAIGHTLINE Splice



Internal assembly shows how conductors feed through as in a deadend. One jaw is removed for a better view.

SPLICE OPERATES LIKE A PAIR OF BACK-TO-BACK STRAIGHT-THRU DEADENDS

The new "55" Series Straightline Splice is the surest splice yet devised for strand . . . and *still* no tools are required.

FEATURES:

1. Burred, bent, or out-of-lay strands are either properly located or are refused by pilot cups.
2. Pilot cups prevent jaws from gripping conductor until conductor is "home".
3. Complete closure prevents entry of gritty materials that can interfere with proper functioning of gripping jaws.
4. With only a straight push conductors reach "home" with a definite *feel* and *sound*.

Write for new bulletin giving complete information. Reliable will gladly give you a demonstration — simply ask for it on your company letterhead.

Reliable ELECTRIC COMPANY

3145 CARROLL AVENUE
CHICAGO 12, ILLINOIS

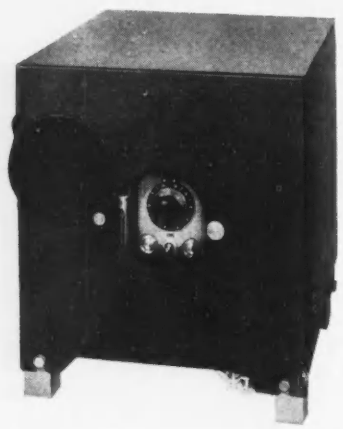
OVER 45 YEARS OF SERVICE TO THE UTILITIES

POWER-LINE CONNECTORS and CONSTRUCTION SPECIALTIES

Everything for transmission lines... via GraybaR

Get continuous, instantaneous records of system frequency and time deviation

. . . with this new *ElectroniK* instrument



NEW TIME DEVIATION DETECTOR
is practically error-proof

In this precision-built element, there are two synchronous motors. One is driven by line frequency, the other by standard frequency from the system's time standard. Both motors are geared to a differential mechanism. As long as both frequencies are identical, the differential stays stationary. When one motor goes faster than the other, the differential's floating spider begins to turn . . . its speed depending on the frequency difference. A Helipot slidewire connected to the spider transmits a d-c voltage determined by the spider position. This voltage, recorded by the *ElectroniK* instrument, is directly related to the system time error.

Precision-cut gears and ball-bearing mountings reduce friction to a minimum. Gears run in an oil bath . . . require no lubrication service.

★ **separate measuring systems:**
two independent pens, driven by separate "Continuous Balance" measuring circuits—one for frequency, one for time deviation; Dual scale calibration facilitates readings.

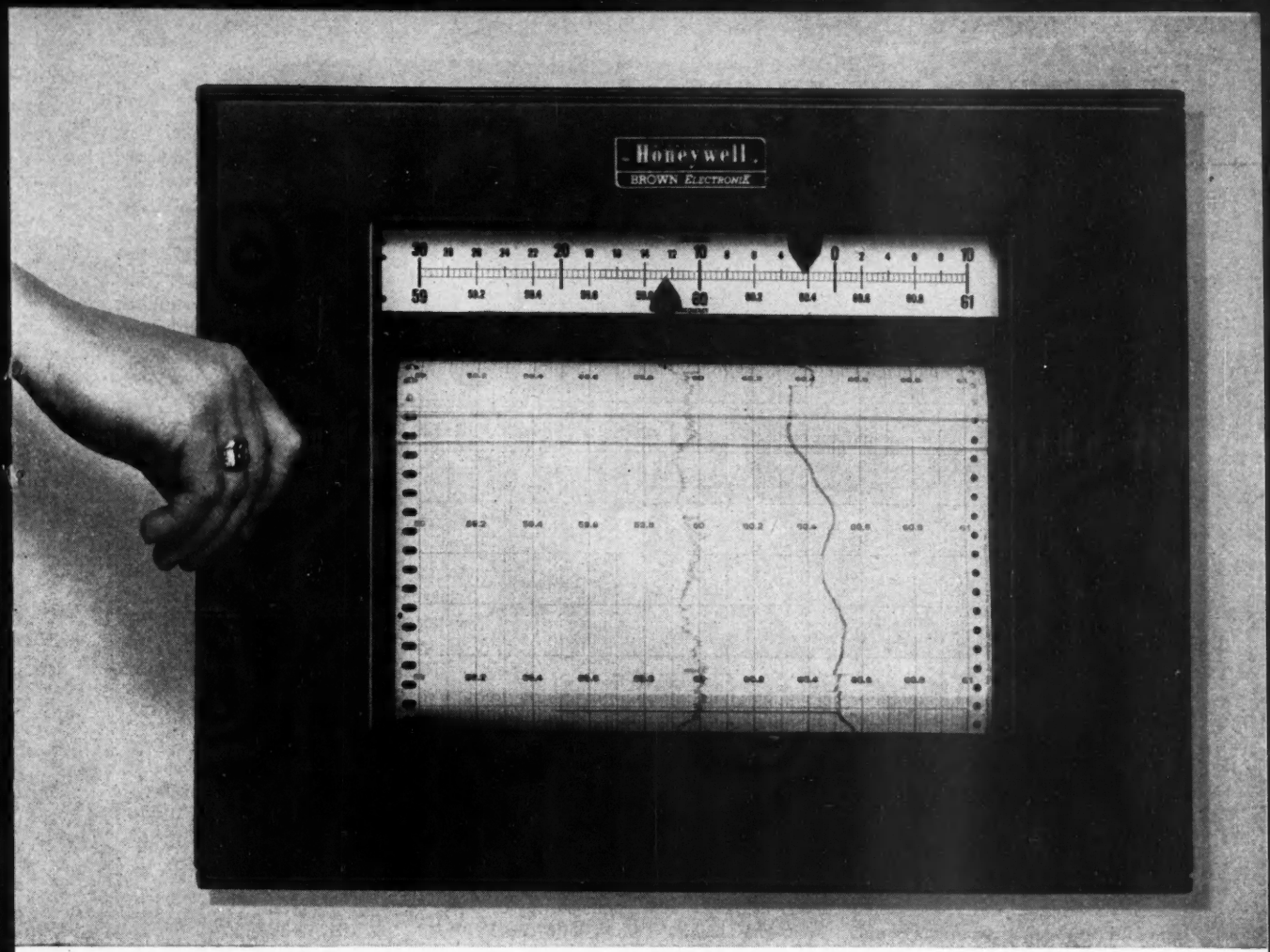
★ **continuous recording:**
every change in time deviation is measured and immediately recorded; no significant variations can go unnoticed. Continuous line record shows trends clearly.

★ **full-scale travel of both pens:**
both the frequency and time deviation ranges extend across the full 11-inch width of chart and scale . . . afford maximum resolution of readings.

★ **shows accumulated time error:**
reads directly in seconds the total deviation between generator frequency and the system's standard time source.

★ **high accuracy:**
new time deviation detector and *ElectroniK* system together have precision within 0.1 second, exclusive of any error in the time standard.

★ **stays in synchronism:**
the recorder can be shut down temporarily for inspection or routine service without losing integrated time measurement. As soon as the recorder resumes operation, it reads total deviation correctly.



Now, for the first time, system operators can have an accurate, continuously-drawn record of time deviation before them as a guide to correction of system time error. The new *ElectroniK* Time Deviation Recorder instantaneously measures and records both time error and frequency on the same chart. Each of these important variables is charted in full, readily legible detail—with a degree of dependability never before achieved.

The instrument embodies two separate "Continuous Balance" measuring systems . . . each operating a separate recording pen. The frequency system is basically the same *ElectroniK* Frequency Recorder which power plants have relied upon for years. For measuring time deviation, an entirely new detecting method is employed which offers exceptional accuracy and reliability . . . working with the industry-proved *ElectroniK* potentiometer.

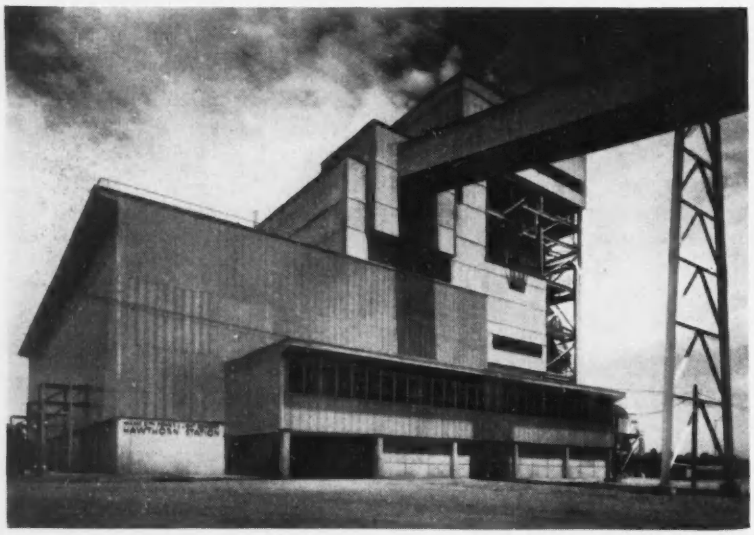
Your load dispatchers and station operators will be able to improve supervision of system frequency with this *ElectroniK* recorder. Our local engineering representative will welcome the opportunity to discuss your specific requirements . . . and he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4568 Wayne Ave., Philadelphia 44, Pa. Service available from more than 80 offices in the United States and Canada.

● **REFERENCE DATA: Write for Instrumentation Data Sheet No. 9.1-14.**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

LETTERS TO THE EDITOR



Kansas City Power & Light Co's Hawthorn steam station

Putting First Things First

To the Editor:

I am somewhat amazed to discover Missouri's backwardness in the installation of new steam-electric generating units.

Your article on page 31 of Electrical World for July 20 states: "Union Electric's Meramec Plant, dedicated June 10th, is the first steam generating station to be built in Missouri since 1903."

Perhaps it is obvious to you that what you meant to say was that Meramec was the first Union Electric steam-electric plant to be built in Missouri in 50 years. But that is not what your headline and first paragraph say, is it?

No great harm done, but we wouldn't like security holders to get the impression that Kansas City Power & Light has not really been at work building, as only one example, the $50-million Hawthorn Station here in Missouri!

J. M. Stafford, Jr., Director
Advertising and Publicity
Kansas City Power & Light Co.
Kansas City, Mo.

• Mr. Stafford is right, of course. Kansas City P&L's Hawthorn Station (see above) was placed in service recently enough so it should have been fresh in the minds of EW editors. The company's Grand Ave Station went into service in 1911 and its Northeast Station in 1919. A spokesman for Union Electric points out that the company has been chary about building steam plants in Missouri until now because cost of getting coal across the Mississippi River has been better than 50 cents a ton, making it more economical to bring the electricity across the river from Illinois plants by way of submarine cables. Now with coal sources in Kentucky, the company is able to barge coal up the Mississippi River to fuel a Missouri plant.

Standardizing Relays

To the Editor:

Your short article in the June 15 issue "What Do You Call It?" should be an eye opener to a lot of relay engineers. I deduce from your statistics that no two companies call their relay systems by the same name. Whether this is good or bad depends upon the results.

The lack of any hesitancy whatsoever on the part of many system planners to throw more and more multiterminal lines and complex configurations at the relay engineer without question as to his ability to properly relay the arrangement is testimony to the soundness of this individuality of relay engineers.

Among others, there is an AIEE subcommittee which is seriously concerned with the problem you present. The initial effort of this group under the leadership of S. C. Leyland was the revision of ASA C-37.1 "American Standard for Relays Associated with Electric Power Apparatus." This was approved Mar. 30, 1950.

No standard is ever really completed and finished, so we are still working on C-37.1 in an attempt to widen its usefulness. Apparently we must also widen our publicity of this standard. Perhaps some of the confusion you received in reply to your question concerning "type of relaying" was due to the fact that this expression is nowhere defined in C-37.1. Paragraph 3.3 identifies "Types of Relays" and paragraph 5.0 identifies "Kinds of Protection." It is interesting to me that you received the kind of answer you did since your question appears to straddle two phases of the protective relay art.

Thanks for publicizing the need for relay standardization.

John R. Linders, Chairman
AIEE Subcommittee
Revision of Standards for
Power Relays
Cleveland Electric Illuminating Co
Cleveland, Ohio

Question of Patents

To the Editor:

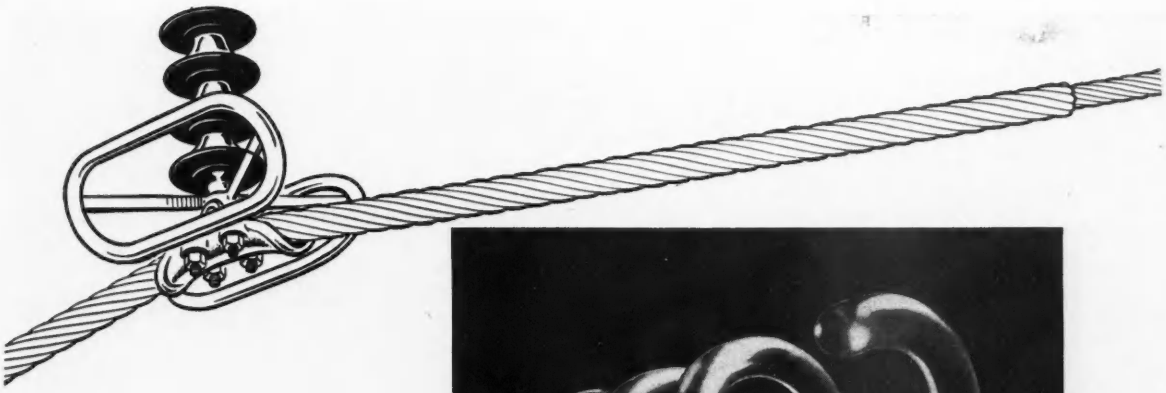
I am writing to have a point clarified in connection with the article "Free-Piston Engine Combustion Doubles Gas Turbine Efficiency" appearing in Electrical World for April 27, 1953.

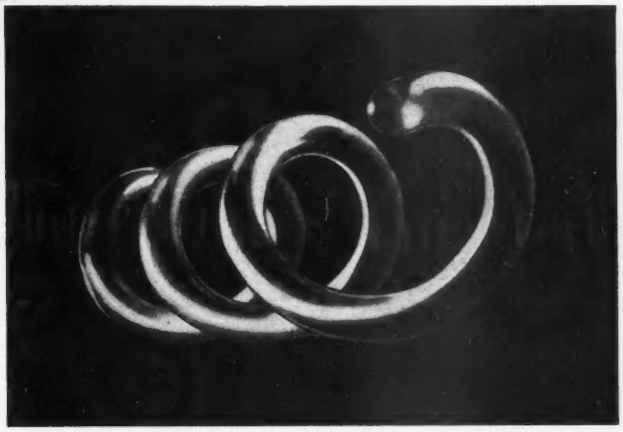
My question concerns patents on the free-piston engine. My impression is that Cooper-Bessemer has developed this engine on their own "after it was revealed that free-piston engines had been used in German submarines," as the article puts it. Is this correct?

Reference to a personal file on gas turbines has produced an article taken from "Mechanical Engineering" an A. S. M. E. publication, April 1947 issue, entitled "Recent Developments in Gas Turbines" by Dr. Adolph Meyer, director and chief consulting engineer. Brown Boveri and Co., Ltd., Baden, Switzerland, in which there is outlined this same free-piston engine.

The engine, as described in Dr. Meyer's article, is illustrated and its

(*Continued on page* 225)





Preformed Armor Rods are UNIFORM

● All Preformed Armor Rods for a given size of conductor are identical. Every pitch is exactly the same. THIS UNIFORMITY, obtained only by "factory-forming" the rods in precision dies with automatic machines, assures the UNIFORMITY of every Preformed Armor Rod assembly. Such inherent UNIFORMITY is maintained, not deformed, during installation or during operation.

PLP UNIFORMITY assures full efficiency of the armor regardless of the size of the conductor, ease of access to the application point, and the skill of the lineman installing it. With Preformed ARMOR rods, no special tools or wrenches are required. Easily installed by hand or hot-line tools, their field service performance can be predicted accurately.

Because the *gripping* action of Preformed Armor Rods is "built-in", they require no end-clamps; they are engineered to retain their initial intimate contact with the conductor throughout their service life . . . nothing to loosen.

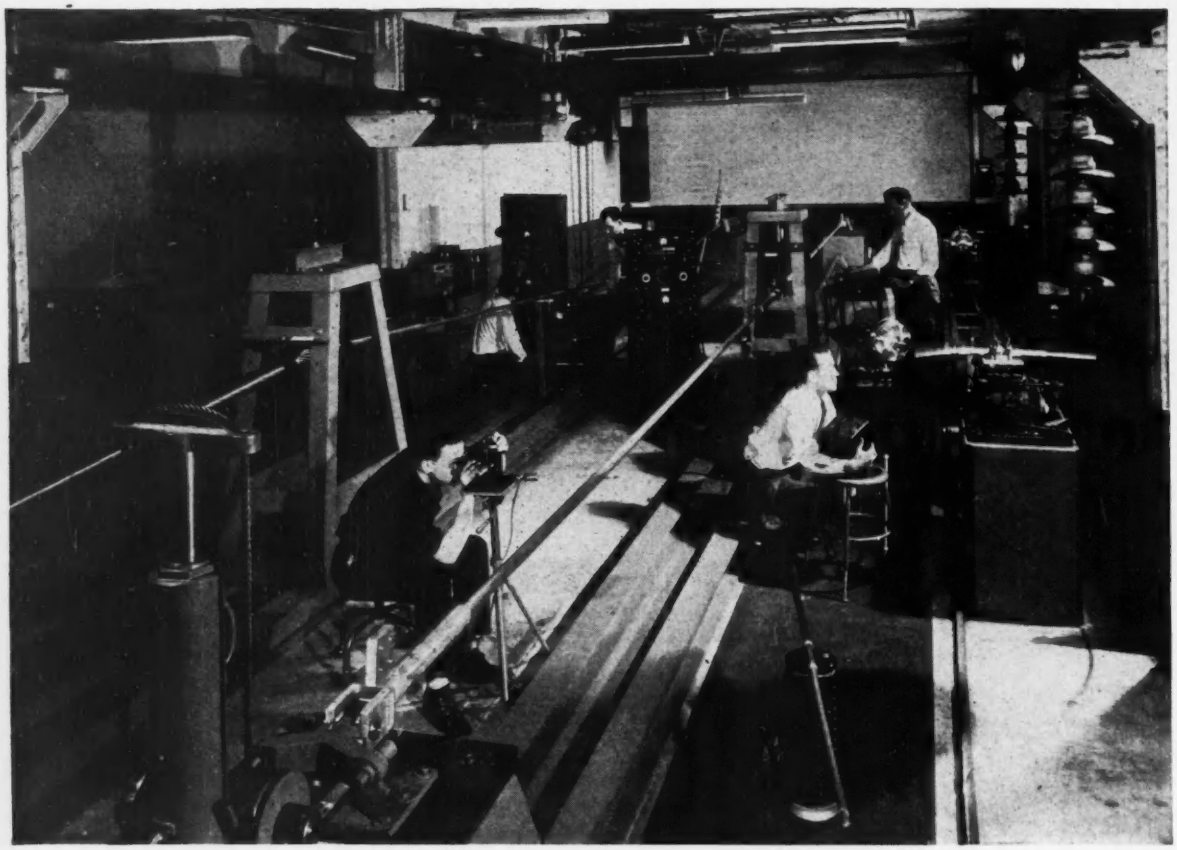
For complete details of their exclusive advantages, write or telephone Cleveland: EXpress 1-3571.

PREFORMED ARMOR RODS:

1—Are "factory-formed" to the individual conductor.
2—Reduce substantially installation time.
3—Increase the effective rigidity of the conductor.
4—Minimize fatigue at suspension clamps . . . lengthen conductor life.
5—Have predictable field service performance.
6—Increase conductance of conductor.
7—Are reusable.

PREFORMED LINE PRODUCTS COMPANY

5349 ST. CLAIR AVENUE • CLEVELAND 3, OHIO



Progressive Ideas...

backed by **EXTENSIVE RESEARCH** *and* **SOUND ENGINEERING**

insure the ultimate in **FIELD PERFORMANCE**

The "ultimate in FIELD PERFORMANCE" is the installation that assures the longest satisfactory transmission and distribution line life. In terms of armor-rod function, this means the best protection against line failure caused by:

1 — CONDUCTOR FATIGUE occasioned by a continuing increase in operating and maximum tensile stresses incident to the introduction of stronger conductors and the building of lines with longer and longer spans.

2 — ARCOVER BURNING at or near suspension clamps and LIGHTNING PITTING anywhere along the line.

3 — CORROSION AND CURRENT-TRANSFER PITTING within suspension clamps, at or near taps and under splices.

4 — UNDUE HEATING of taps, splices and so on, caused by the differential expansion of dissimilar metals or of metal stressed beyond its elastic limit.

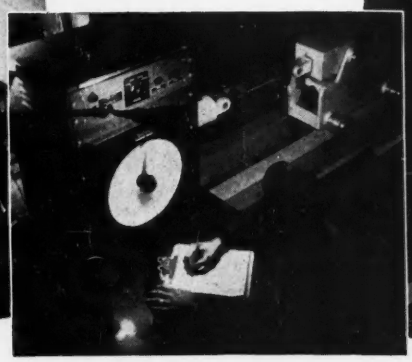
It is almost impossible, in the case of a line failure, to isolate one or another of the causes, but with Preformed Armor Rods, it is not necessary.

PREFORMED ARMOR RODS by virtue of their inherent and unique characteristics effectively take care of all the above-mentioned problems. Conductors are relieved of mechanical stress at points of support. They are protected against burning, corrosion and overheating, and all of this is done at every point of application with almost unbelievable uniformity and consistency.

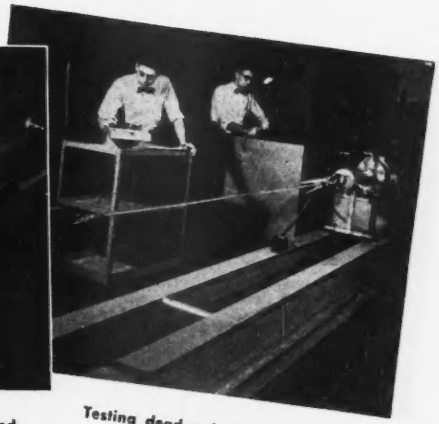
Preformed Armor Rods are today's... not yesterday's... answer for increasing conductor life.

For complete details of their outstanding and exclusive features, write or phone Cleveland: EXpress 1-3571.

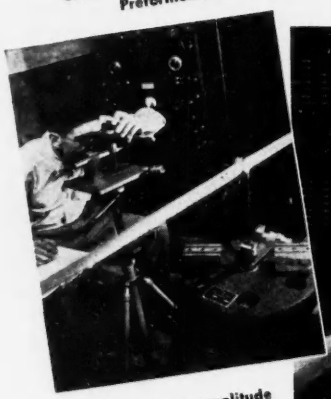
Checking the fatigue characteristics of Preformed Armor Rods.



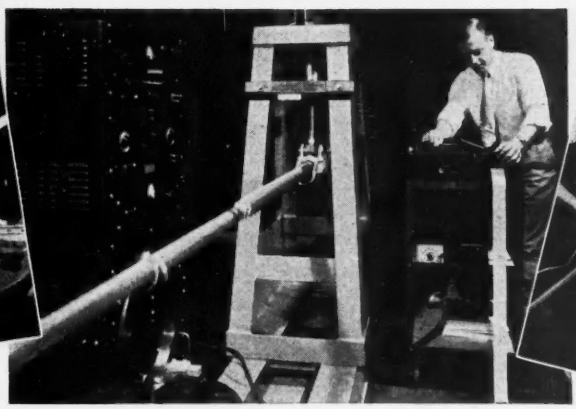
Tensile testing of wire used in Preformed Armor Rods.



Testing dead-ends for strength at elevated temperature.



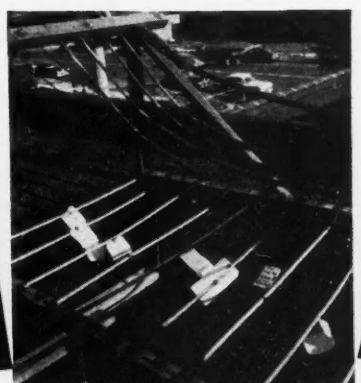
Measuring vibration amplitude of Drake, 795,000 CM ACSR.



Measuring dynamic stresses in a conductor at suspension point.

Determining application characteristics of Preformed Armor Rods.

Salt fog splice test conducted in lucite cabinet.



Outdoor weathering racks in industrial corrosive atmosphere.

Testing for conductance properties after accelerated weathering.

PREFORMED LINE PRODUCTS COMPANY

5349 ST. CLAIR AVENUE • CLEVELAND 3, OHIO

TELEPHONE: CLEVELAND EXpress 1-3571

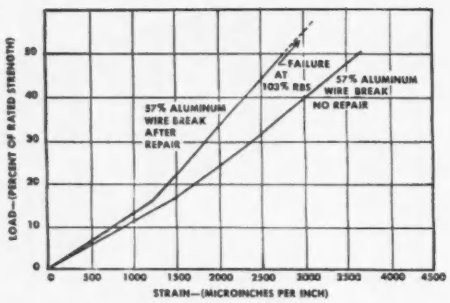
HOW Preformed Armor Rods LENGTHEN CONDUCTOR LIFE

★ The most vulnerable spot of a transmission line is under the suspension clamp. You can get no better armor protection than Preformed Armor Rods. They are always *uniform*—always do the same perfect job—factory engineered and factory formed—no variation in installation. Their intimate contact with the conductor provides the necessary reinforcement without any of the rub or chafe between rods and conductor, which you might expect in a looser installation. Furthermore, they will never loosen. They are not dependent on tightening of bolts which might crush the conductor if improperly applied—and which may become loose.

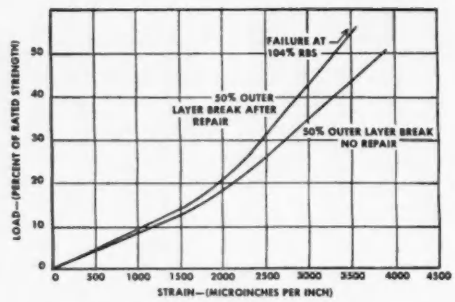
But this is only part of the story: While Preformed Armor Rods will provide the *best* and *safest* protection, they have another *unique* function—they do a job which only Preformed Rods can do. Regardless of armor efficiency, some vibration damage may occur. Should a strand failure occur at the suspension point, Preformed Rods will automatically take on the load, restoring strength and conductance—thereby continuing and lengthening conductor life.*

After all, your interest is in maintaining service—in continued functioning of your transmission lines. You need no longer consider the life of your conductor jeopardized by a strand failure. Preformed engineering has seen to this.

* Many have encountered vibration, chafing and burning failures on unarmored conductors and have used Preformed Armor for repairing and restoration of conductors at those points.



Strength restoration of No. 4, 7 x 1 ACSR (rated breaking strength—2288 lbs.) by Preformed Armor Rods.



Strength restoration of 795 MCM, 26x7 ACSR (rated breaking strength—31,200 lbs.) by Preformed Armor Rods.

These two charts tell the story. Irrespective of conductor size and construction, the clamping characteristics of PREFORMED Armor Rods result in restoration of the strength of damaged conductors to within at least 5 per cent of the rated breaking strength of the original conductors. And remember . . . only with PREFORMED Armor Rods . . . can laboratory tests accurately predict field service performance. There are no "average" installations.

SALES REPRESENTATIVES:

C. B. Anderson Co., *Tulsa* ● Bergstrom-Verberg Co., *Minneapolis* ● Vincent J. Brown Co., *Buffalo* ● Burns Electric Co., *Pittsburgh* ● Earl S. Condon Co., *Los Angeles* ● Cory and Crum, *Indianapolis* ● The Electrical Distributors Co., *Philadelphia* ● Engineer Sales Co., *St. Petersburg* JSG Electric Co., *Chicago* ● E. L. Flowers, *Boston* ● George R. Horne & Co., *Dearborn* ● Johnson Sales Co., *Bay City* ● H. L. Macon & Co., *Atlanta*, Peterson Co., *Denver* ● Elgin B. Robertson, Inc., *Dallas* ● Elgin B. Robertson Co., *Houston* ● K. M. Ryals Co., *San Francisco* ● Shaffer and Nelson, *Portland, Seattle, Spokane* ● M. H. Snyder & Sons, *New York* ● Curtis H. Stout, *Little Rock, Memphis, New Orleans* ● L. G. Wendegatz, *Kansas City*

Letters

(*Continued from page* 220)

application is identical with the one in the article in Electrical World. Credit in Dr. Meyer's article for development of the engine is given Sulzer Bros., Switzerland, and leaves little doubt but that they hold patents on it.

Will you clarify this matter for me?

M. M. Cloud
Louisiana Power & Light Co
Rayville, La.

• Through the good offices of R. L. Boyer, vice president and chief engineer of the Cooper-Bessemer Corp, we have learned: "The free piston idea is not at all new, having been experimented with by a number of manufacturers. The general idea is, therefore, not only not patentable, but no one holds any patents today. The important point, though, is that the free piston was not successful in most of the developments and it has taken a great deal of study, time, and money to make it a practical scheme. In these developments many new ideas have appeared which are patentable. Some patents are held by foreign interests and several, of course, covered detailed developments of our own."

Heating in Canada

To the Editor:

Probably most of your readers, being resident in the United States, think that Canada is a pretty cold country where electric house heating would not have much chance of successful application. On the contrary, it is making good progress, so good in fact that I felt it advisable to write to B. C. Fairchild, managing director of the Canadian Electrical Association:

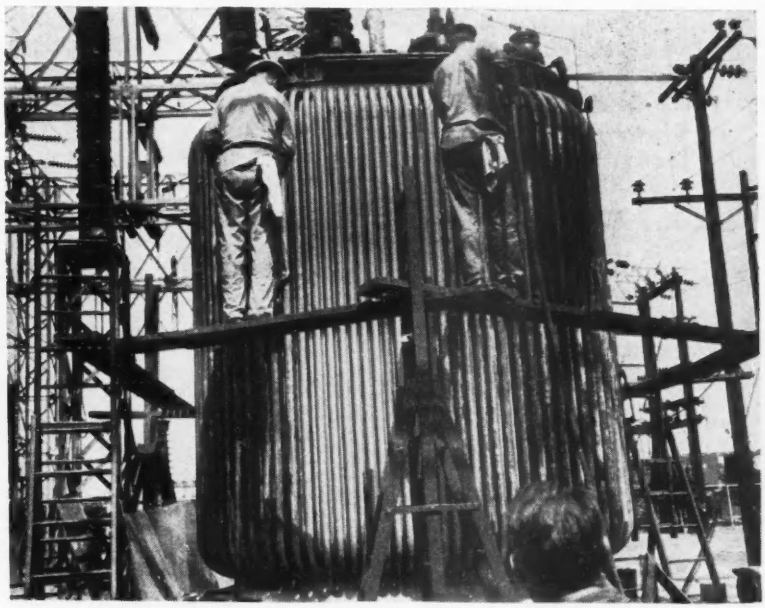
"The use of electricity for space heating is growing so rapidly that it has become desirable that all of the organizations concerned, such as C.S.A., Canadian Electrical Manufacturers Association, Central Mortgage and Housing Corporation, the Adequate Wiring Bureau, Canadian Electrical Association, etc., cooperate in assisting in its proper development.

"A few days ago, I had occasion to meet with the executive of C.M.H. in Ottawa, and our discussions pointed up the fact that the electrical indus-

(*Continued on page* 228)

SUBOX guards all three! { STRUCTURES EQUIPMENT FENCES

with maximum protection and minimum application



• Subox paints assure both good radiation and excellent protection for transformers and sub-station equipment. They are easily applied by brush, spray or flow-coating. Use them on your present equipment—specify them on your present equipment—specify them on your new.

• All varieties of Subox and Subalox can now be supplied with a faster-drying vehicle for distribution transformers and other shop work.

• Sub-station structures can often be painted with a single coat and a minimum of outages.

• Industrial-type fences can be amply protected with one coat applied by floor brooms.

For simplified low-cost upkeep, write for free pamphlet "Electric Light & Power Maintenance".

Subox Inc.

3 FAIRMOUNT PLANT HACKENSACK, N. J.

G.E. starts delivery of 66 giant breakers to guard the nation's first 330-kv lines

A huge 80-ton steel-clad circuit breaker—that can shut off in 1/20 of a second more electrical energy than any other breaker in present use throughout the world—will shortly take over the job of protecting the 330-kv transmission system of American Gas & Electric Company, the country's first.

With its three characteristic lens-shaped tanks, the new 330-kv impulse breaker was shipped from General Electric's High Voltage Switchgear Department in Philadelphia to Beverly, O., for the Muskingum River Plant of The Ohio Power Co., an operating company of AG&E. The unit, 25 feet high completely assembled, is a forerunner of 16 gigantic 3-pole G-E breakers in the AG&E System.

First developed by G.E. 20 years ago, the time-proved impulse oil blast principle has been applied to the new family of breakers in the 138-kv to 330-kv range. This breaker design has withstood 2000 interrupting tests at G.E.'s new high capacity Switchgear Development Laboratory during the year preceding shipment—plus 40,000 electrical tests for best operation under all possible conditions.

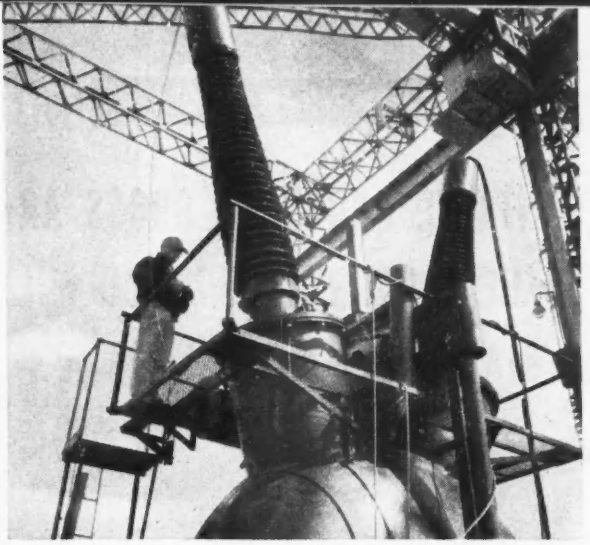
G.E. is building 66 breakers, for various purchasers, capable of interrupting up to 25,000,000 kva, all for new 330-kv systems. These steel-blue giants, standing guard over the high-power lines, represent the vision and enterprise of the nation's electric utilities, coupled with the creative research and design which made the breakers possible.

General Electric Company, Schenectady 5, N. Y.

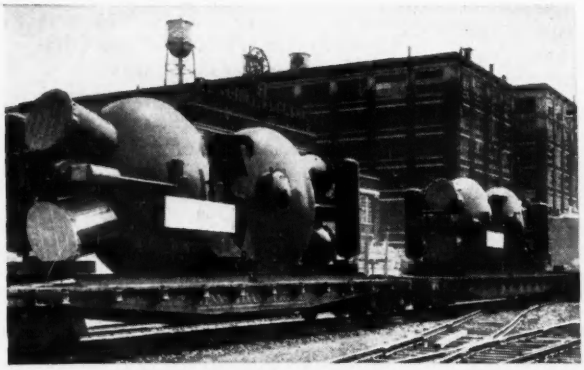
872-6

(Advertisement)

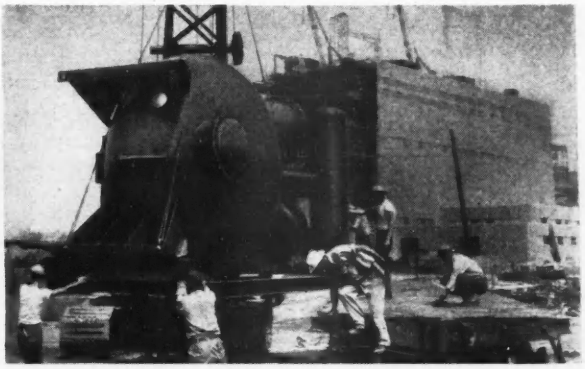
1. PLANNED from the beginning. General Electric engineers developed a breaker capable of controlling and protecting the large blocks of power to be handled by AG&E's new system.



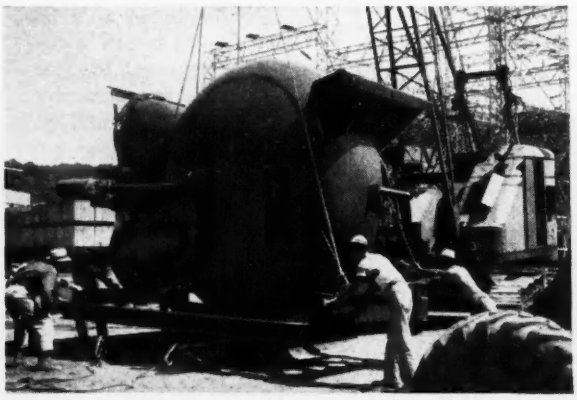
2. TESTED for interrupting performance at Switchgear Development Laboratory in Philadelphia, these new breakers meet all specified requirements. 2000 development tests were performed.



3. SHIPPED from G.E.'s High Voltage Switchgear Department in Philadelphia, these "giants" had to be laid on their sides on flatcars to meet railway clearances.



4. UPON DELIVERY at Muskingum, crane lifts last tank, with shipping cradle attached. Under construction in background is the AG&E Muskingum River Plant.



5. LENS-SHAPED TANK, moving across field for placement, is formed from two seam-welded flanged domes. This design can withstand extremely high pressures, keeps volume to minimum.

6. ONE TANK in position, another going up. Each has a 3550-gallon oil capacity. Installation of six breakers is scheduled for completion this year at the Muskingum plant.

You can put your confidence in—

GENERAL ELECTRIC

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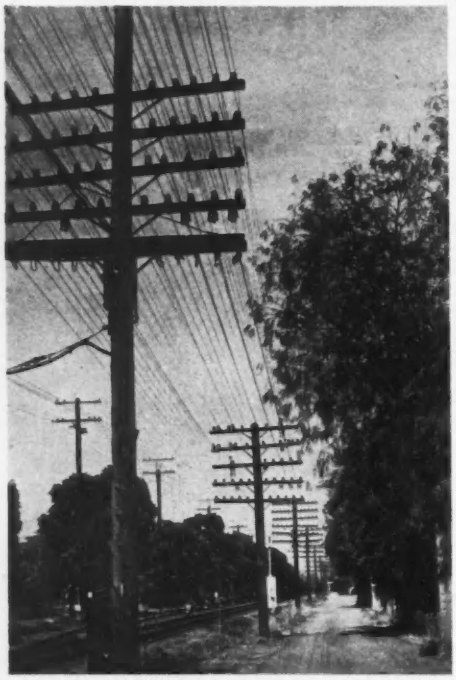
INDUSTRY NEWS IN BRIEF . . .

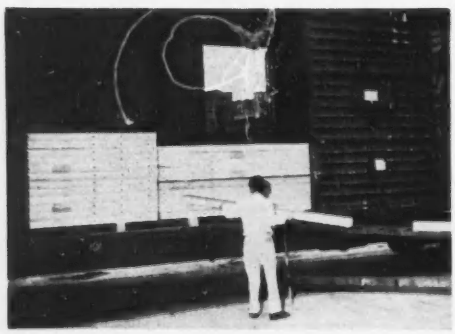
SANTA FE PRODUCES CROSS ARMS TO HELP CARRY 71,600,000 MILES OF AERIAL CABLE ACROSS NATION



Carloads of *cross arms* to help support America's extensive network of telephone and telegraph cable is being prepared for shipment at Santa Fe Tank & Tower Company plant.

The 71,600,000 miles of America's aerial telephone and telegraph wire, stretched to every corner of the nation, rests on the broad *shoulders* of countless *cross arms*. And it is interesting to note that these *cross arms*, though simple and unimpressive in appearance, have extremely rigid engineering standards upon which manufacture is based.

The Santa Fe Tank & Tower Company, one of the oldest and more experienced in this field, is utilizing an elaborate system of automatic machinery for *precision* surfacing, boring, shaping, sizing and treating of cross arms. The sudden, and usually large quantity demands for cross arms, makes it necessary for Santa Fe to maintain a large supply of cross arm *stock* for constant *seasoning*, either by air or kiln drying. First, of course, they must be carefully *graded* and all strength-reducing defects removed.



To increase the durability of the cross arm, and eliminate the necessity of costly replacement, Santa Fe treats them with either creosote or pentachlorophenol. This process helps to keep moisture and decay fungi from penetrating to the interior of the *arm*. Since the *replacement* of a cross arm in the line is often many times the cost of the arm itself, every last detail in their production becomes vital to *lasting* service.

Santa Fe plant facilities and inventory are among the largest for this specialized type of *cross arm* construction. Branch offices are maintained in all principal cities. For complete information and engineering data on Wood Pipe, Cooling Towers, Wood Tanks, Cylindrical Gas Scrubbers, and other industrial wood products, write Santa Fe Tank & Tower Company, 5401 So. Boyle Avenue, Los Angeles 58, California.

Letters

(*Continued from page* 225)

try's associations had so far failed to provide them with the proper data on which they could base an adequate specification for mortgage purposes.

"On top of this, I attended a meeting of the rate structure section at the C.E.A. convention at Murray Bay which was entirely devoted to the subject of space heating. Here again it was evident that there was a great need for adequate data. In my opinion, such data should be made available by the aforementioned associates, and without such supervision the whole industry will suffer severely.

"The starting point of course is recognition of the fact that the use of electricity, for space heating is dependent on the co-ordination of a number of factors, the heating units themselves may be of secondary importance. Some of these factors:

(1) The suitability of the structure
(2) The use of the structure
(3) The location of the structure
(4) Type of construction
(5) Orientation
(6) The heat loss factor
(7) Reverse heat loss of units
(8) Adequate capacity and proper location of heating units
(9) Other electrical loads in the structure
(10) The wiring and power supply
(11) The number of thermostats per 100 sq ft
(12) The load limiting controls
(13) Warranty inspection after installation

"It is therefore suggested that the Canadian Electrical Association give consideration to assisting, possibly on a joint associations' committeee, to provide a specification which will meet all of the above requirements."

I enclosed with this communication copy of a letter from the Central Mortgage and Housing Corporation indicating their interest in the matter.

Mr. Fairchild replied saying that he would be glad to bring my letter to the attention of the CEA executive committee for consideration of my suggestion for creation of an industry committee to study this problem.

So you see that long cold winters do not necessarily rule out electric house heating.

Marshall M. Foss, President
Glassheat of Canada, Ltd
Toronto, Canada

2,4,5-T FORMULATIONS

When brush begins to choke your right of way, release its grip with formulations of 2,4,5-T.

This potent herbicide eliminates mesquite, poison ivy, poison oak, barberry, brambles and many other woody and unwelcome plants. At the same time, it permits the growth of grass and low-growing cover plants that prevent erosion.

Deadly to brush, 2,4,5-T formulations are non-toxic to man or animals. Economical, too... effective in low concentrations. And easy to apply with ordinary knapsack sprayer, truck, tractor or trailer-mounted equipment.

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ETHYL CHEMICALS ETHYL CORPORATION

Orselli Named a Vice President

Bechtel Corp advances veteran employee to executive post in Power Division, to assist Senior VP Yates

A. J. Orselli has been named a vice president of Bechtel Corp, a San Francisco engineering and construction firm. He has been assigned to the firm's Power Division and will act as assistant to Senior Vice Pres J. P. Yates.

The company also elected Myles C. McGough vice president and Eastern Division manager and Fred W. Meyer vice president in the Refinery Division.

Orselli, who started his career with Bechtel in 1933, recently was manager of construction for the company's Eastern Division. Prior to assuming the construction post, he was manager of Bechtel's Refinery Division. Before joining Bechtel he was associated with Pacific Gas & Electric Co.

A. J. ORSELLI

Northern States Reassigns 9

Streamlining of Northern States Power Company's operating department has brought new duties and increased responsibilities to nine of its members.

Earl Ewald, who has been manager of electrical operations, has been assigned to the new position of manager of operations, which carries with it considerably broadened administrative responsibility.

J. A. Colvin, formerly manager of power production and system operation, now becomes an engineering consultant and will deal with special problems created by the company's expansion program.

L. A. Cobb moves up from general superintendent of steam plants to the new position of general superintendent of power production with responsibility for steam, hydro and internal combustion plants.

E. A. Willson, who has been assistant manager of power production and system operation, now occupies the new position of general superintendent of system operation with responsibility for load dispatching and associated activities.

T. L. Jarchow, formerly general superintendent of electric distribution, has now been made general superintendent of transmission and distribution.

A. G. Keely, general superintendent of construction, has been promoted to the new position of director of research, construction and insurance.

D. F. McElroy, construction superintendent, has been moved up to the position of general superintendent of construction. He is in direct charge of all construction department activities, with Keely providing only overall supervision.

J. W. Hoffman has been assigned to the new position of fuel engineer, which is connected with the procurement of fuels.

W. F. Patterson, budget engineer, has been assigned to co-ordinate all budget activities for the operating department.

•

John G. Miller, superintendent of production, has been made responsible for supervision of generating stations for Metropolitan Edison Co, Reading, Pa. He joined Met-Ed in 1947 after serving six years with the Detroit Edison Co's engineering department.

Walter S. McCormick, superintendent of the Ashtabula plant of Cleveland Electric Illuminating Co since 1950, has been made superintendent of the utility's Eastlake power plant, now under construction. His successor at Ashtabula is **Leonard J. McKay,** assistant superintendent for the past three years.

Harry L. Smith, Jr, staff manager of product sales for Aluminum Co of America, has been named director of the Aluminum Division of the National Production Authority to succeed **T. A. Lynch,** who has returned to Reynolds Metals Co.

E. Gordon Black, vice president and treasurer of Milwaukee Gas Light Co, has been advanced from vice chairman to chairman of the Accounting Section of the Wisconsin Utilities Association. He succeeds **George F. Betts,** chief accountant of Wisconsin Natural Gas Co. **Roy F. Miller,** vice president and treasurer, Northern States Power Co, succeeds Black as vice chairman.

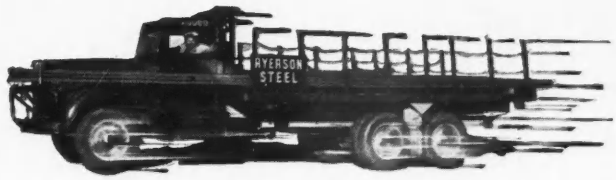
Robert W. Dittmus, who has been in charge of the substation design department of Electrical Engineers Equipment Co, Melrose Park, Ill., for a number of years, has been appointed sales manager of the company. He joined EEE in 1940.

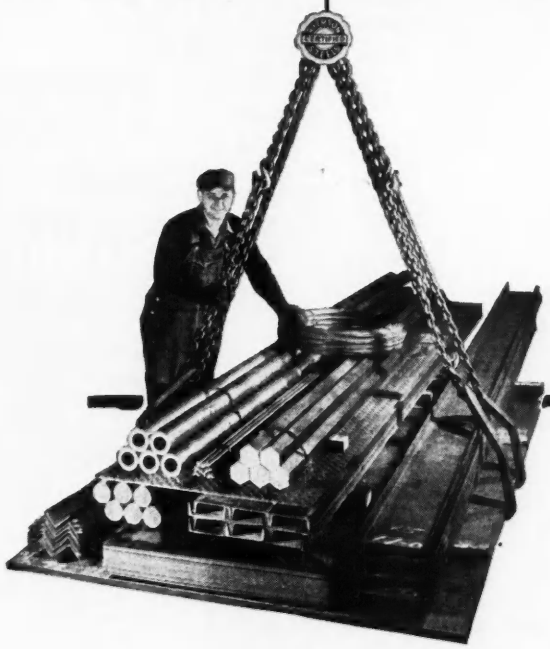
John H. Winchell, a Denver attorney, has been made chairman of the Colorado Public Utilities Commission to succeed **Joseph W. Hawley,** who stepped down at his own request.

Clarence S. Cole has been appointed general superintendent of operations at Niagara Falls, N. Y., for Niagara Mohawk Power Corp. He succeeds **Ralph E. Robida,** who retired after 43 years service.

Clyde R. Braun has been appointed manager of the nuclear power section of Allis Chalmers Manufacturing Co. Braun, who joined Allis-Chalmers in 1940, recently returned to the company after a year's leave of absence

For quick delivery





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With a network of 15 strategically located plants Ryerson brings quality steel quickly to your door. Although some stocks are currently unbalanced from a size standpoint, when you need steel—any kind or quantity—call the Ryerson plant nearest you and we will do our best to meet your every need.

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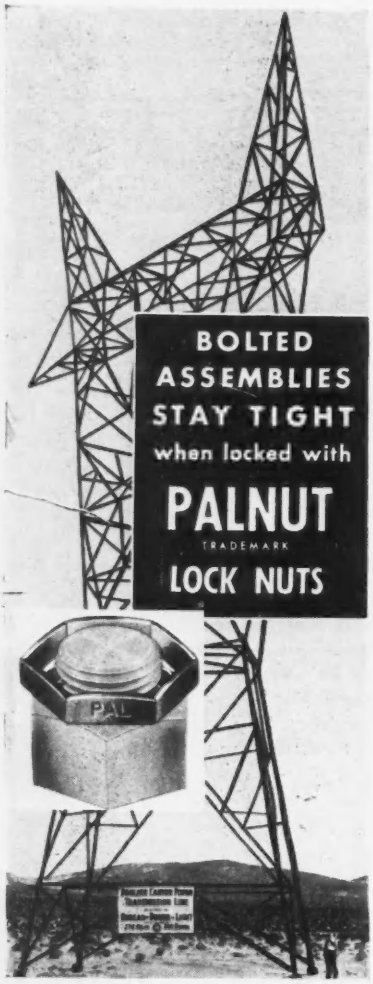

Specify PALNUTS on new lines . . . add PALNUTS to existing lines, to eliminate further re-checking and re-tightening of bolts. PALNUT Lock Nuts are the lowest cost, most dependable method of locking steel tower bolts. Once tightened, their double locking spring action holds tight under severest vibration.

PALNUTS are extremely low in cost, require only 3 bolt threads, apply fast, may be removed and reused. Hot Dip Galvanized and other finishes and materials used by utility industry. Free samples on request.

The PALNUT Co.
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Irvington 11,
New Jersey

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TRADE MARK
LOCK NUTS
for quick, secure fastening at low cost

to serve as chief of the steam turbine section, Engine and Turbine Division of National Production Authority.

Milton H. Frank, executive vice president of Wisconsin Power & Light Co since 1951, has retired from active service after 41 years in the utility field. Frank, affiliated with the utility for more than 25 years, will remain as a member of the company's board of directors.

Gov Langlie Appoints 4 to Power Commission

Gov Arthur B. Langlie has activated the Washington State Power Commission with the appointment of four members, the fifth to be named after nominations have been received from the City of Tacoma.

Four-year terms went to Thomas Quast of Marysville, chairman of the Snohomish County PUD, representing the PUDs, and Otto Warn, Spokane shoe retailer, representing the public at large. Two-year terms went to Bob Jones, chairman of the utilities committee of the Seattle City Council, representing the City of Seattle, and Roy Skill of Yakima, assistant vice president of the Pacific Power & Light Co, representing the public.

Tacoma has delayed its nominations because of a reorganization in its form of government.

•

Fred A. Hubbard has been named superintendent of electric operations for New Bedford (Mass.) Gas & Edison Light Co. His former post of electric electrical engineer has been filled by **Edward E. Dahill, Jr,** head of maintenance since 1946.

Albert E. Maibauer has been named manager of the Wire & Cable Materials Division of Union Carbide & Carbon Corp's Bakelite Division. Maibauer, who joined Bakelite in 1925, succeeds **J. E. Brister.**

Virgil B. Day has been named manager of union relations for General Electric Co, succeeding **George H. Pfief,** who retired after 48 years with the company.

Roy E. Nelson has been promoted to the newly created post of manager of semi-conductor equipment sales

• Eliminate checking and re-tightening
• Eliminate radio interference due to loose hardware

Every bolt-and-nut assembly locked with PALNUT Lock Nuts stays tight, despite weather, wind, stress and vibration. PALNUTS, tightened on top of the regular nuts, prevent loosening and falling off. Very low in cost—easily, speedily applied—require little space—may be used on new or existing assemblies. Heavily galvanized by hot dip process to meet A.S.T.M. Specifications. Stocked by all leading pole line hardware manufacturers.

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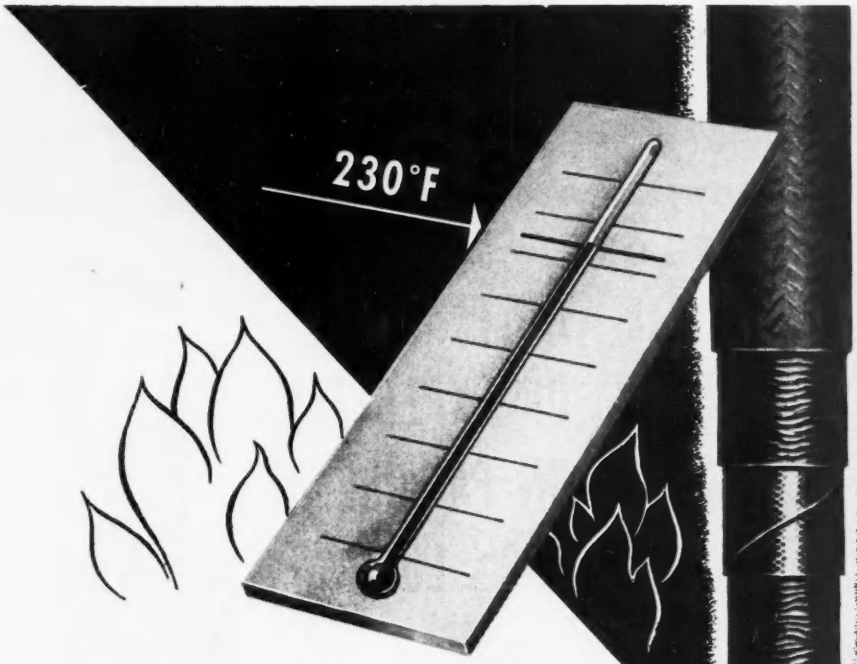

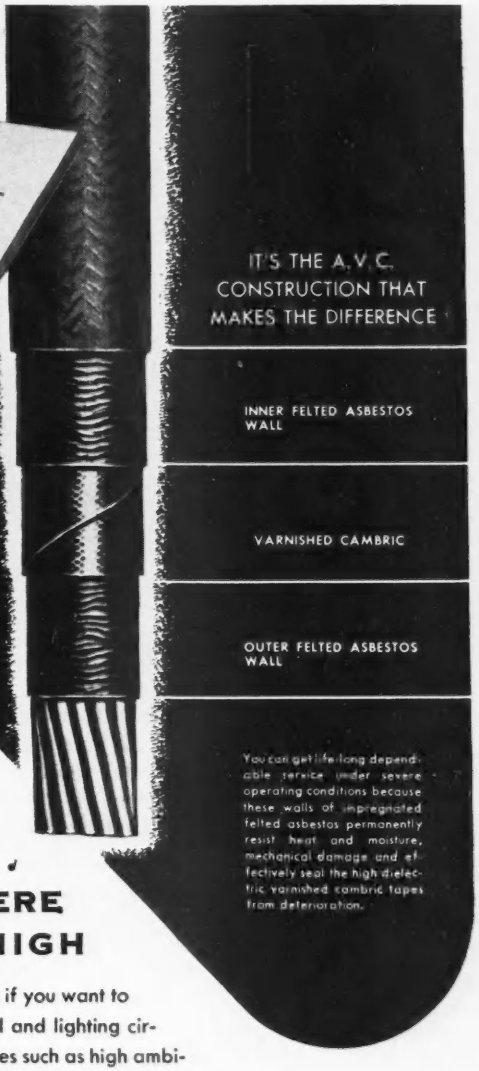
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VARNISHED CAMBRIC
OUTER FELTED ASBESTOS WALL
You can get life-long dependable service under severe operating conditions because these walls of impregnated felted asbestos permanently resist heat and moisture, mechanical damage and effectively seal the high dielectric varnished cambric tapes from deterioration.

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Get started on a failure-prevention campaign if you want to avoid future trouble in your power, control and lighting circuits. Look into all possible trouble-sources such as high ambient temperatures, probable overloads, exposure to moisture, oil, grease and corrosive fumes . . . then specify Rockbestos A.V.C., (AVA) the wire designed to meet these conditions.

These permanently insulated wires and cables guarantee long and trouble-free service in circuits exposed to severe operating conditions because they have an impregnated asbestos insulation that is heat and flame resistant. It won't bake brittle, crack or flow in temperatures up to 230°F . . . and won't deteriorate with age or rot when exposed to oil, grease or fumes.

Protect "hot-spot" circuits around boilers, furnaces, kilns, soaking pits, pump rooms, steam tunnels and heat-exposed ducts with Rockbestos A.V.C. (AVA). It will eliminate re-wiring jobs and expensive maintenance. 125 different standard types are available in 600 to 5000 volt ratings.

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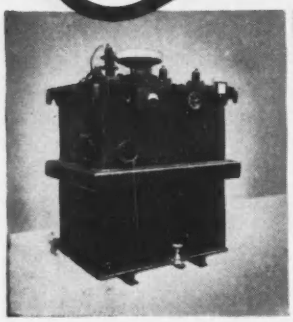
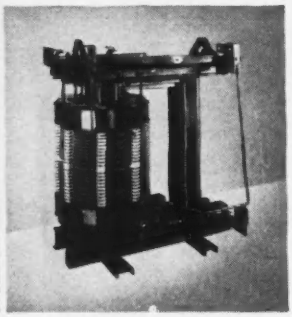
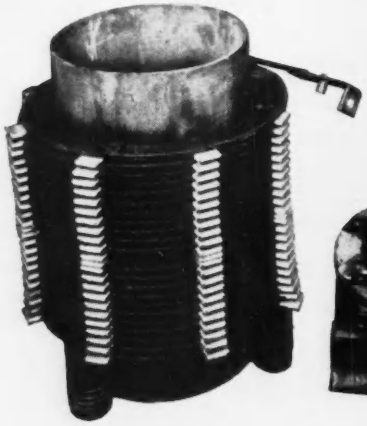
DOW CORNING SILICONES

make transformers safer





NO FLAME OR EXPLOSION ON FAILURE AT 600% LOAD



A major problem in the operation of transformers has been the hazard of fire or explosion that may attend failure. We have overloaded many silicone (Class H) motors to failure during the past 10 years without a single fire. Westinghouse engineers at Sharon, Pennsylvania, have recently proved that totally enclosed, Class H insulated transformers are equally safe.

They progressively overloaded a 50 KVA unit to destruction* with a spark gap arcing over the core and coil every 50 seconds. Immediately following a number of tests at lesser overloads (up to 500%), after 10 minutes at 600% the transformer finally dropped its load. There was no disturbance.

At the time of failure, the high voltage coil was operating at an average temperature of 660°C. Failure took place in the low voltage coil at the normal location of the hottest spot in the winding. It is probable that a turn to turn fault occurred, although the winding temperature approached the melting point of copper. Vapors in the case reached a temperature of 310°C and a calculated pressure of 16 psi without fire or explosion.

That's the type of emergency performance you can expect of Class H insulation made with Dow Corning silicones. For the electrical manufacturer that means unprecedented freedom in design. For the user of transformers, Class H insulation means maximum safety and overload protection with minimum maintenance.

You can be sure you're getting the most for your money when you specify Class H transformers, motors, solenoids and Silastic† lead wire and cable.

* Sealed Dry Type Transformers Proved Safe by Test, Tipton, AIEE Summer General Meeting, June 15, 1953. AIEE Technical Paper 53-45.

† Registered trademark for Dow Corning silicone rubber.

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DOW CORNING CORPORATION, DEPT. AY-8
Midland, Michigan

Please send me

- ☐ Sources of Supply, Class H Transformers
- ☐ Data on new silicone resins and varnishes
- ☐ Data on the performance of Class H motors
- ☐ List of Class H rewind shops

Name _____ Title _____

Company _____

Street _____

City _____ Zone ____ State _____

DOW CORNING CORPORATION
Midland Michigan

DOW CORNING SILICONES

ATLANTA CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D. C. (Silver Spring, Md.)

In Canada: Fiberglas Canada Ltd., Toronto

In Great Britain: Midland Silicones Ltd., London

for the Tube Department of the RCA Victor Division, Radio Corp of America. He will be responsible for sales of RCA transistors to equipment manufacturers.

Gordon E. Medlock has been elevated from assistant sales manager to sales manager of Stearns Magnetic, Inc, Milwaukee. With the company since 1946, Medlock assumes responsibility for sales of the company's line of magnetic separation and power transmission equipment.

W. B. Young, assistant treasurer and auditor for Puget Sound Power & Light Co at Everett, Wash., before being transferred to Wenatchee, Wash., several years ago, has returned to Everett as assistant manager of the Snohomish County PUD.

Lester H. Graves, vice president of Curtis Lighting, Inc., has retired after 41 years of service with the company.

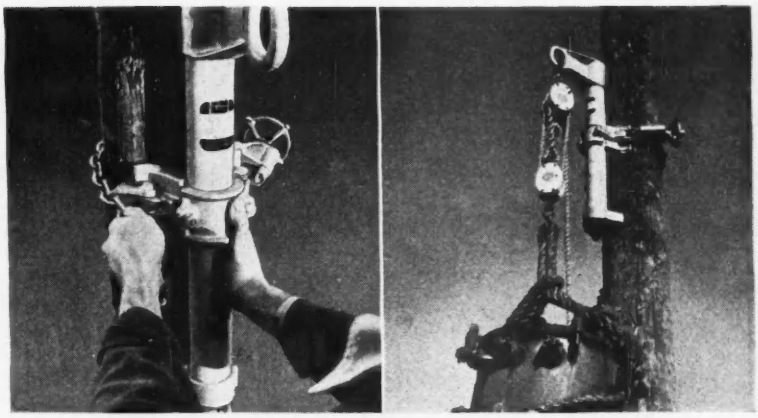
E. J. Byrnes, Jr., has been appointed assistant general manager of sales, Eastern Division, of Colorado Fuel & Iron Corp. In June, 1925, prior to the merger with CF&I, Byrnes joined the then Wickwire Spencer Steel Co. His executive offices are located in New York City.

Harry B. Knights, distribution engineer for Boston Edison Co, has retired from that utility after many years' service and has established a consulting engineering office in North Weymouth, Mass.

Colin W. Raff, director of publicity and advertising for Montana Power Co, has been named an executive assistant of the utility.

John E. McMaster has been appointed safety engineer of New England Gas & Electric Service Corp with headquarters at Cambridge, Mass. Before joining the service corporation in 1947, he was associated with affiliated companies in the NEGEA system for more than 25 years.

J. R. Johnstone has been named manager of the carbon products sales department of National Carbon Co, a division of Union Carbide & Carbon Corp. In his new post Johnstone will handle sales of carbon and graphite



It takes only 17 seconds to install Dieck's New Insulated Gin

Has Dieck's New Spin Tite Tightener. Actual trials show this gin can be attached to pole in 17 seconds. No more time than required for a rope sling and safer to use.

- Light weight—only 12 lbs.
- Max. load—830 lbs. using double blocks and snatch block at base of pole.
- Blocks and SE-electric manila rope also available.

Information available on our complete line of light and heavy duty gins.

DIECK TOOLS

BODENDIECK TOOL COMPANY
325 EAST MAIN STREET —•— TAYLORVILLE, ILLINOIS

Cut Your Installation Costs!

Drive Rods TWICE AS FAST with 1/2 the manpower

using a KEARNEY GROUND ROD DRIVER

No more tedious, time-consuming sledge driving. Actual field tests have shown that *one man* using a KEARNEY GROUND ROD DRIVER can drive two 8-foot rods in less time than it takes two men to drive one rod by old-fashioned methods.

Operator simply inserts any length of rod through the hollow handle. Rod is gripped near the ground by a heavy chuck. Downward blows of the handle against the chuck quickly drive the rod, the weight doing most of the work. Old rod may be easily pulled out of the ground by reversing this procedure.

WRITE FOR PRICES— JAMES R. KEARNEY CORPORATION
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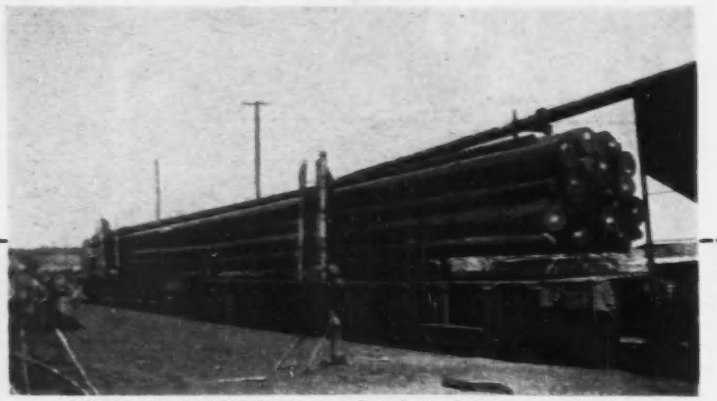
JAMES R. KEARNEY CORPORATION ST. LOUIS MO. GUELPH, ONT.

217

For Better Construction SAFER Maintenance



A Double Load of 100-ft. Western Red Cedar Poles at our Minnesota Transfer Treating Plant

WESTERN RED CEDAR POLES
for TRANSMISSION LINES . . .

We maintain large stocks of Northern White and Western Red Cedar and Douglas Fir Poles in the heart of the Middle-West so that we can serve you promptly.

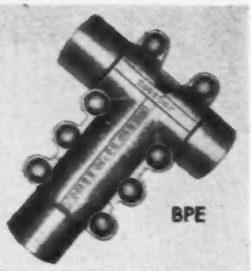
Full length Penta Treatment or Creosote Butt Treatment

The MacGillis and Gibbs Company

1615 E. ROYALL PLACE MILWAUKEE, WISCONSIN
• *SERVING THE PUBLIC UTILITY INDUSTRY SINCE 1902*

DOSSERT

POWER CONNECTORS



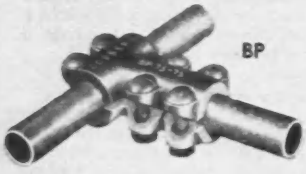
FOR POWER TRANSMISSION AND SUBSTATIONS

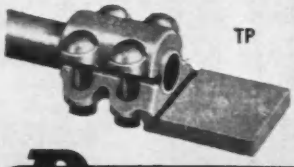
Available in all combinations for tubular and flat bar bus, wire, and cable conductors . . . copper to copper, aluminum to aluminum, and aluminum to copper.

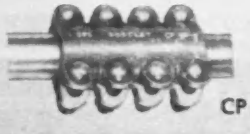
Write for Catalog 53-1. For aluminum connectors—Catalog A54-1.

Immediate delivery on all standard items.

Prompt delivery on specials.







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MFG. CORP.
349-355 HURON STREET, BROOKLYN 22, N. Y.
SINCE 1904

brushes for motors and generators. An electrical engineer, he joined National Carbon in 1937.

William E. Jacobs has been appointed assistant division superintendent of the Western Division of Consumers Power Co. He joined the utility in 1923.

S. R. Naysmith has resigned as vice president in charge of engineering of the Illuminating Division of Miller Co, Meriden, Conn. Naysmith, who was elected vice president in 1942, was associated with the company for 28 years.

Joseph E. Theobald has been named assistant comptroller in charge of general accounting of Dayton Power & Light Co. He has been supervisor of reports and voucher control department for three years, and has been affiliated with DP&L since 1927.

Lloyd K. Yerger has been appointed superintendent of the meter and test department in Buffalo, N. Y., for Niagara Mohawk Power Corp. He succeeds **Nelson B. Phillips,** who retired after 44 years service.

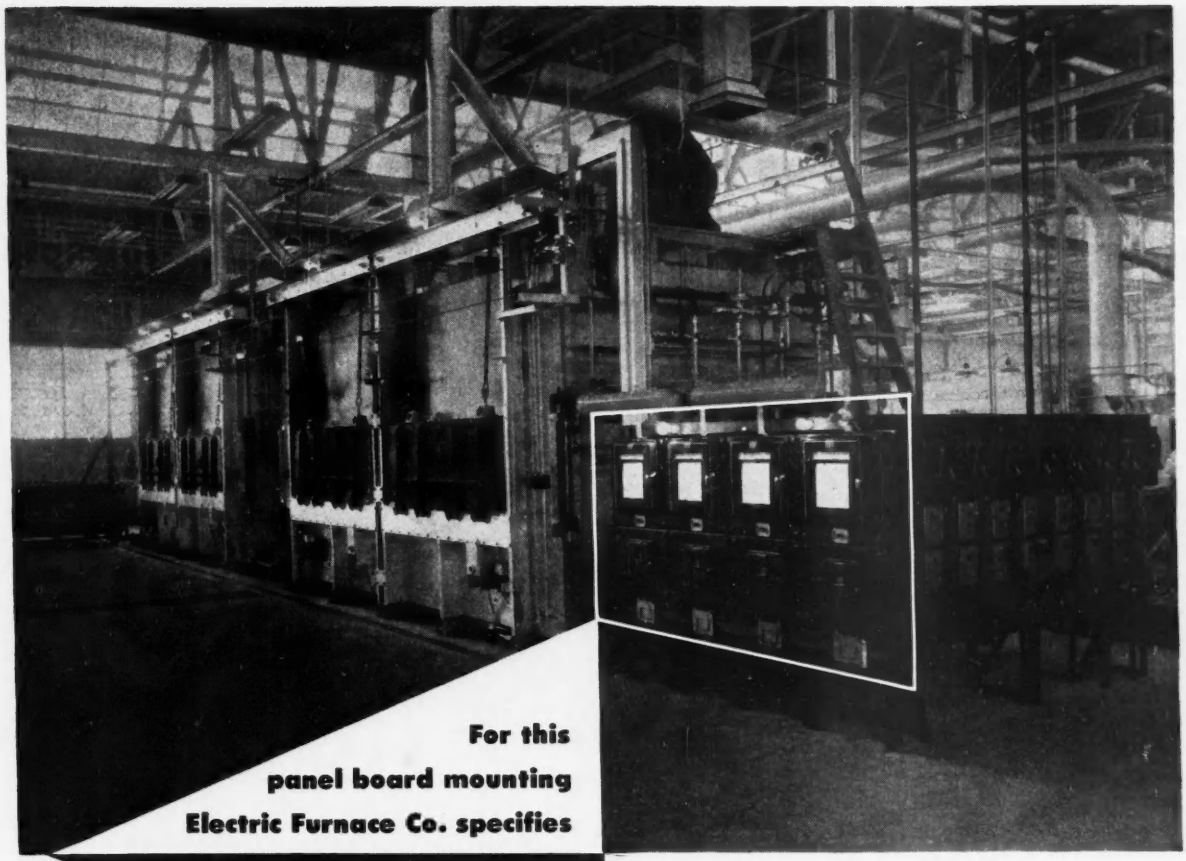
OBITUARY

W. F. Sims, 77, retired chief electrical engineer of Commonwealth Edison Co, died recently. He retired from the engineering post in 1943 after serving the utility 32 years. Identified with technical activities of various national engineering organizations, he was a fellow of American Institute of Electrical Engineers and a member of the Western Society of Engineers.

James J. Russell, 67, chairman of the board of Revere Copper & Brass, Inc, died Aug. 1 at New York. Affiliated with Revere since 1904, Russell was elected chairman of the firm in 1951 after serving several years as president.

Waldo H. Beauvais, 56, chief engineer of the Webster Street generating station of Worcester (Mass.) County Electric Co, in Worcester, died at Auburn, Mass., Aug. 8.

Lawrence B. Maas, 48, a field engineer in the electrical engineering section of Central Illinois Public Service Co, died July 22. He had been with the utility for 31 years.



For this panel board mounting Electric Furnace Co. specifies

K&M Ebonized Asbestos

The above illustration features two EF gas fired double ended recirculating draw furnaces for treating aircraft engine parts, manufactured by the Electric Furnace Company, Salem, Ohio. K & M Ebonized Asbestos is well suited for the control panels, because of its high resistance to severe shocks, vibration, rapid temperature change and its exceptionally high dielectric strength.

For switchboards, bus bar supports, cabinets, compartment linings, bench boards, testing tables, and such—it is ideal. It is made in thicknesses from ⅛″ to 4″, giving it a wide range of usefulness.

Perhaps this time-tried product can help solve one of *your* design problems! Write us for complete specifications on K & M Ebonized Asbestos, or for answers to questions about particular applications.

KEASBEY & MATTISON COMPANY • AMBLER • PENNSYLVANIA
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K&M best in asbestos®

Nature made asbestos...
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Interior Awards Contracts . . .

. . . for electrical equipment to Allis Chalmers and Japanese firm. Units slated for BPA's high voltage transmission system

Interior Department last week announced award of two electrical equipment contracts involving the administration's "Buy American" policy.

The department awarded one contract to a domestic firm and the other to a foreign firm, although foreign firms were low bidders on both contracts. Equipment to be supplied is for Bonneville Power Administration's high voltage transmission system.

Policy Change?? . . . The Interior action gives no clear-cut indication of a change in the government's "Buy American" policy beyond showing that the new Republican Administration is not judging bids exclusively on the price tag.

Successful bidders on the contracts were:

Allis-Chalmers Manufacturing Co, which won a $2,005,378 contract to furnish two banks of 345-kv autotransformers for BPA's ultra-high tension line between McNary and Ross dams.

Nippon Gaisha, Kaisha, Ltd, of Japan, which won a $298,000 contract to supply 100,000 high voltage suspension insulators for a 345-kv transmission line.

Autotransformers to be built by Allis-Chalmers will be among the highest voltage transformers installed and operated in this country. Contract calls for delivery of six 120,000 kva, 345-230-13.2 kv single-phase autotransformers for a 345-kv line.

Foreign Firms Lack Experience . . . In announcing award of the transformers contract, Interior said, "The two foreign bidders on this invitation did not meet the specifications with respect to experience in the field of very high voltage and large capacity equipment." It was determined that with few exceptions the foreign firms had not contracted for or delivered equipment in the voltage classes above 230 kv. Further it was found that the firms had little experience with the American practice of reduced insulation levels.

On the strict price basis, however, the foreign firms beat American bids by several hundred thousand dollars (see Table I).

TABLE I
Bids on six 345-kv autotransformers

American Elin Corp of Austria	$1,375,550
Ferranti Electric, Ltd, of England	1,527,400
ALLIS-CHALMERS	2,005,378
Westinghouse	2,042,112
General Electric	2,517,534

For the insulator contract, Nippon Gaishi Kaisha with a bid of $298,000 f.o.b. Seattle beat out nine domestic firms. The domestic firms all submitted base bids of $408,000 f.o.b. shipping point except Porcelain Products Co of West Virginia, which included a $50,000 delivery allowance in its bid.

Sample bids for the insulators were:

TABLE II
Bids on 100,000 units high voltage suspension insulators

Firm	Base Bid	Price Plus Freight
NIPPON GAISHA KAISHA, LTD OF JAPAN		
off color insulators	$298,000	$309,968
standard glaze	300,000	309,970
Porcelain Products Co		
standard glaze	408,000	394,369
R. Thomas & Sons Co		
standard glaze	408,000	440,918

As far as could be determined, this contract was awarded on the basis of the "Buy American" policy which Interior followed under the Democratic Administrations. In general the policy works like this: A 25% differential is added to the base bid of foreign competitors. If, when this is added to the foreign bid it still is below the lowest American bid, the contract may be awarded to the foreign firm.

Using this formula to evaluate the competing bids for the 100,000 insulators, Interior came up with these figures: Japanese bid, $355,000. Low American bid, $358,000.

Submitted Sample Units . . . In addition to beating the domestic bid, the Japanese firm also submitted sample units to BPA for testing. These successfully passed electrical and mechanical tests.

Although these contracts have long been the center of a behind-the-scenes controversy, there is the chance that tougher decisions are still pending. Interior has before it bids for a number of 230-kv transformers, and again foreign bidders are low.

Detroit Edison Biggest User of 'Power Kits'

Biggest single user of Westinghouse Electric Corp's educational "Electric Power Kits" has been Detroit Edison Co, which has purchased 1,000 kits.

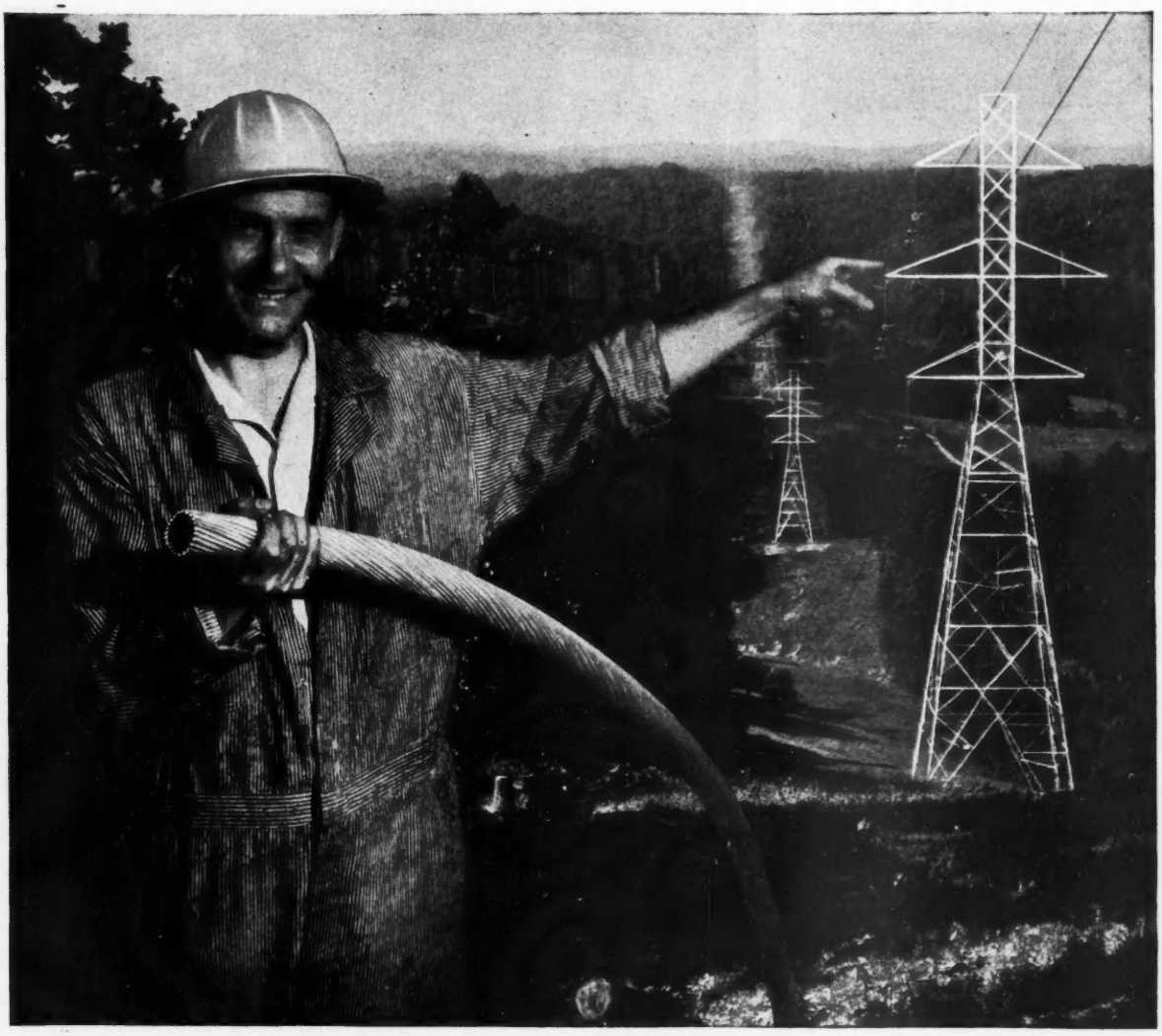
To date, Westinghouse has sold some 6,000 kits to 220 different utility organizations for use with the schools in their areas. Westinghouse reports that the experience of utilities using the kit seems to have been thoroughly satisfactory.

The kit, introduced in the fall of 1952 (EW, Sept. 29, p 46), contains related teaching aids designed to help young students—grades 7 through 9—to get a better understanding of

MANUFACTURERS' EARNINGS

Company	Period Months Ended		Net Income 1953	Net Income 1952	Earnings Per Common Share 1953	Earnings Per Common Share 1952
Bowser	6	June	$208,773	$422,302	$....	$....
Clark Equipment	6	June	3,071,230	3,295,102	2.71	2.90(a)
Combustion Engineering	6	June	3,663,787	2,573,100	3.79	2.67
Continental-Diamond Fibre	6	June	426,259	378,522	.93	.82
Cooper-Bessemer	6	June	954,398	1,339,803	1.76	2.39(a)
Foster Wheeler	6	June	1,002,596	577,058	1.76	1.01
Walter Kidde	6	June	521,000	515,000	2.49	2.49
McGraw Electric	6	June	3,651,000	3,641,000	3.60	3.59
Remington Arms	6	June	3,053,916	2,779,990	.40	.36
Rome Cable	3	June	524,000	562,925	1.05(b)	1.15(b)
Square D	6	June	1,941,329	2,334,994	1.41	1.69
U. S. Rubber	3	June	7,283,739	6,708,728	1.13	1.01
U. S. Rubber	6	June	14,440,347	12,956,461	2.23	1.95
Weston Electrical Instrument	6	June	647,112	586,825	1.51	1.37(a)

Notes—(a) On number of shares now outstanding; (b) On shares outstanding at close of the period.



There's more here than meets the eye!

THIS IS EXPANDED ACSR

It's hot stuff—330,000 volts hot. It carries voltage much higher than any transmission line in America ever did before.

This wrist-thick expanded ACSR answers the need of America's utilities for a conductor capable of transmitting tomorrow's super voltages safely and *economically*.

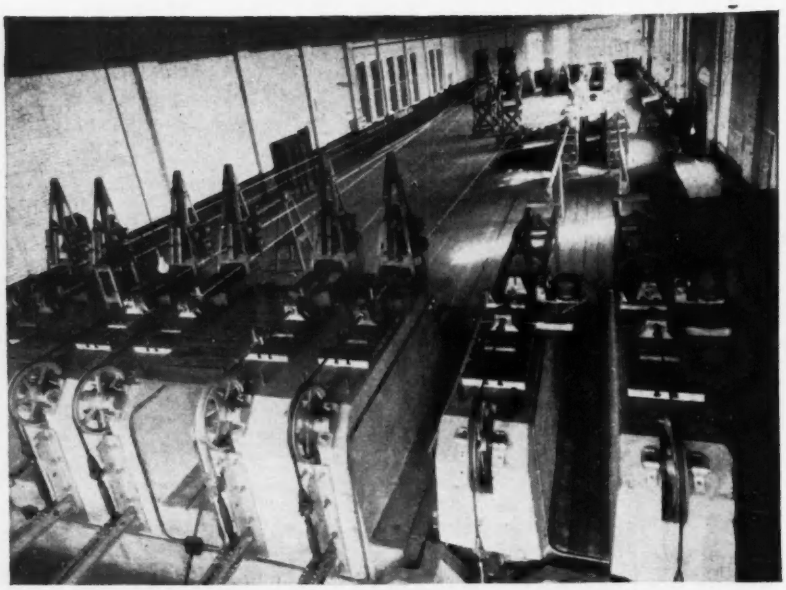
A product of co-operation between utility engineers and Alcoa, it is the latest development in a series of achievements which started with the introduction of the first ACSR forty-three years ago.

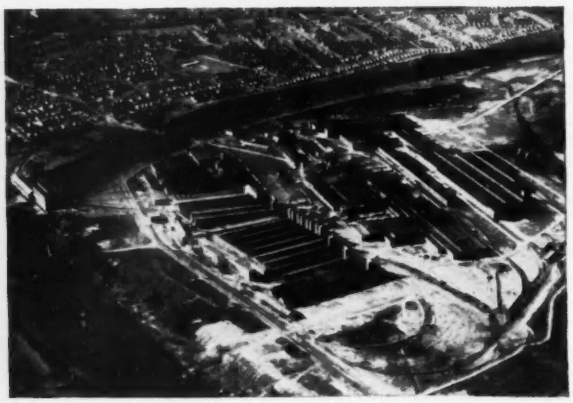
Achievements made Alcoa first in aluminum. Behind each were research and development facilities, production facilities, service facilities unrivaled in the industry. These facilities continue to keep Alcoa first in aluminum conductors.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

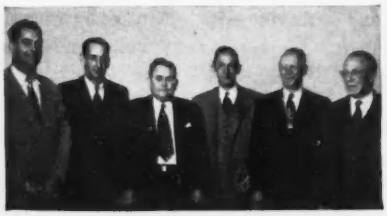
GIVING CABLE THE SHAKES, on special vibration equipment like this, is one of the many ways Alcoa develops and tests electrical conductor. Thousands of tests in Alcoa's laboratories are your assurance that Alcoa® Aluminum Conductors and Accessories are right—on the line.





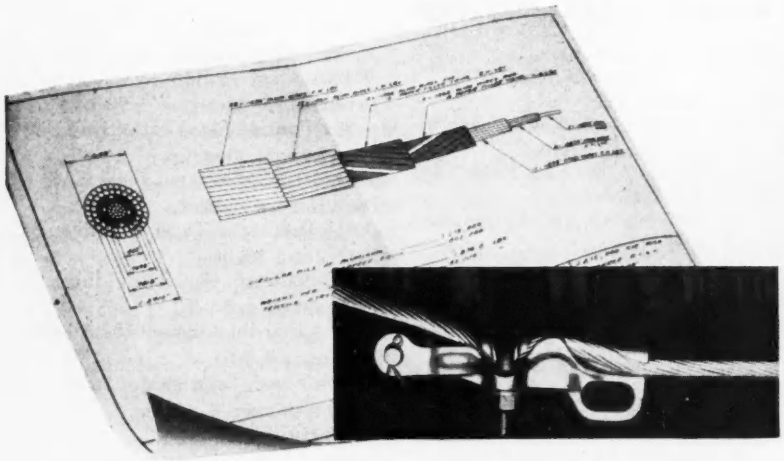
OVER 2,000,000 MILES OF ACSR have been produced by Alcoa in its plants at Massena, N. Y., and Vancouver, Wash. Designed and equipped to give you the best in quality, located to give you the best in service, these plants produce the most complete line of aluminum conductors.

DATED MAY 30, 1912, this Alcoa field service report is the first of many made on a line that's still in service. In the forty-one years since the report was written, Alcoa has been adding constantly to its first-hand knowledge and on-the-job experience.



OVER ONE HUNDRED YEARS of customer service—an average of seventeen years per man—have been amassed by the six Alcoa Electrical Conductor Supervisors shown here. You'll find Alcoa men—and Alcoa Aluminum Electrical Conductors—on the tough jobs.

WRITTEN BY ALCOA'S staff of electrical engineers, their subjects range from products to procedures; their contents from *Amperes* to *Voltage Drop*.



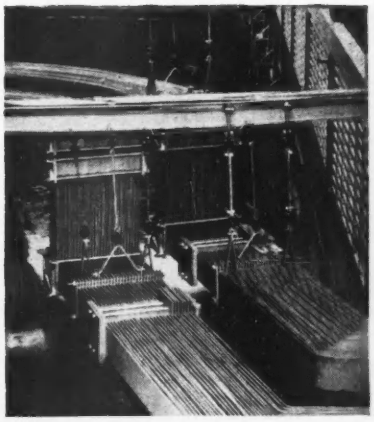
EXPANDED ACSR is designed to provide the large diameters required for conductors at super voltages. The customary relationship between strength and loaded weight of conductor is maintained; the increased diameter economically obtained by introducing nonmetallic filler strands in the intermediate layers of the cable.

ANCHOR CLAMP is result of growing demand for a small, convenient clamp for all-aluminum cable in urban distribution lines. Cast from tough aluminum alloy, it handles limited tensions up to 3000 pounds and provides tensile strength of 5000 pounds between pin and pulling eye.

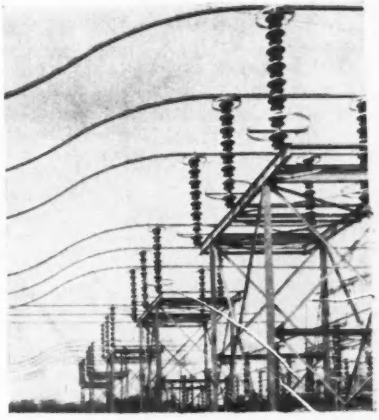
BOTH PRODUCTS are the result of the same painstaking research, engineering and manufacturing standards which developed the other aluminum electrical conductor products shown here.

Alcoa Aluminum

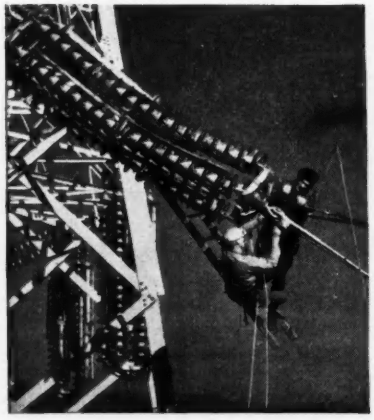
ALUMINUM COMPANY OF AMERICA



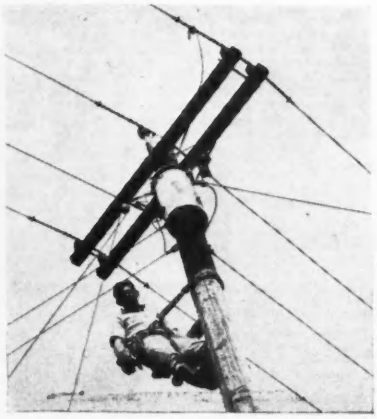
ALCOA RECTANGULAR BUS BARS have had long experience. Those illustrated were installed in 1898. Recent installations have shown 50% savings when compared with copper.



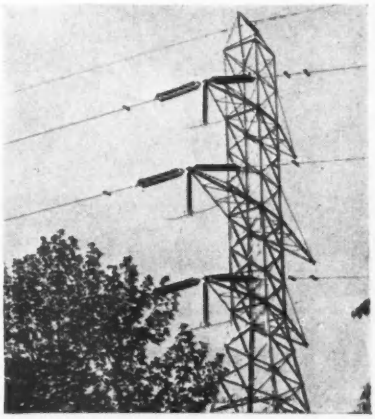
ALCOA OFFERS from its alloys the one most suitable for any tubular bus conductors.



ALCOA ACCESSORIES are available for any aluminum conductors. Developed and tested by Alcoa, first in aluminum conductors, they are manufactured under rigid quality controls.



ALCOA ALL-ALUMINUM CONDUCTORS, solid and stranded, bare and covered, are finding increasing use in primary and secondary distribution systems. Construction moves faster because of light weight. Linemen like it.



ALCOA ACSR and Alcoa expert service help solve special span problems —sometimes involving new designs of ACSR to meet special strength requirements.

ALCOA SALES OFFICES

AKRON 8, OHIO
506 Akron Savings & Loan Bldg.
ALBANY 7, N. Y.
90 State Street
ALLENTOWN, PA.
1132 Hamilton Street
ATLANTA 3, GA.
1800 Rhodes-Haverty Building
BALTIMORE 1, MD.
400 Baltimore Life Building
BIRMINGHAM 3, ALA.
505 First National Building
BOSTON 16, MASS.
20 Providence Street, Park Square
BRIDGEPORT 4, CONN.
Atlantic Street
BUFFALO 7, N. Y.
1880 Elmwood Avenue
CHARLOTTE 2, N. C.
616 Johnston Building
CHATTANOOGA 1, TENN.
1205 Volunteer Building
CHICAGO 11, ILL.
520 North Michigan Avenue
CINCINNATI 2, OHIO
801 Enquirer Building
CLEVELAND 13, OHIO
1450 Terminal Tower
COLUMBUS 15, OHIO
40 South Third Street Building
DALLAS 2, TEXAS
301 Thomas Building
DAVENPORT, IOWA
503 Kahl Building
DAYTON 5, OHIO
207 Northtown Arcade
DENVER 2, COLO.
524 U. S. National Bank Building
DETROIT 2, MICH.
610 New Center Building
EVANSVILLE, INDIANA
320 N.W. Seventh Street
FORT WAYNE, IND.
930 Lincoln Bank Tower
GRAND RAPIDS 2, MICH.
812 Michigan National Bank Bldg.
HARTFORD 3, CONN.
Capitol Building, 410 Asylum St.
HOUSTON 2, TEXAS
1804 Commerce Building
INDIANAPOLIS 4, IND.
303 Guaranty Building
JACKSON, MICH.
1405 National Bank Building
KANSAS CITY 5, MO.
2300 Power & Light Building
LOS ANGELES 14, CALIF.
108 West Sixth Street
LOUISVILLE 2, KY.
1152 Starks Building
MIAMI 32, FLA.
1605 Alfred I. du Pont Building
MILWAUKEE 2, WIS.
735 North Water Street
MINNEAPOLIS 2, MINN.
1060 Northwestern Bank Building
NEWARK 2, N. J.
744 Broad Street
NEW ORLEANS 12, LA.
627 Whitney Bank Building
NEW YORK 17, N. Y.
230 Park Avenue
OKLAHOMA CITY 2, OKLA.
1606 Liberty Bank Building
OMAHA, NEB.
708 Omaha National Bank Bldg.
PEORIA 1, ILL.
725 Commercial Natl. Bank Bldg.
PHILADELPHIA 9, PA.
123 S. Broad Street
PITTSBURGH 19, PA.
1501 Alcoa Building
PONTIAC 15, MICH.
301 Pontiac State Bank Building
PORTLAND 4, ORE.
1115 U. S. National Bank Bldg.
PROVIDENCE 3, R. I.
815 Industrial Trust Building
RICHMOND 19, VA.
712 Southern States Building
ROCHESTER 4, N. Y.
1331 Lincoln Alliance Bank Bldg.
ST. LOUIS 8, MO.
10th Floor, Continental Building
SAN FRANCISCO 4, CALIF.
615 Russ Building
SEATTLE 1, WASH.
1411 Fourth Avenue Building
SOUTH BEND 1, IND.
805 J.M.S. Building
SPRINGFIELD 3, MASS.
232 Tarbell-Watters Building
SYRACUSE 2, N. Y.
408 State Tower Building
TAMPA 2, FLA.
227 First National Building
TOLEDO 4, OHIO
1801 Ohio Building
WASHINGTON 6, D. C.
1200 Ring Building
WICHITA 2, KAN.
1011 Central Building
WILMINGTON 28, DEL.
301 Delaware Trust Building
WORCESTER 8, MASS.
22 Pleasant Street
YORK, PA.
205 Manufacturers Building

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MANUFACTURING BRIEFS

Merger of Allis-Chalmers Manufacturing Co, Milwaukee, and Buda Co, Harvey, Ill., has been proposed. Buda plans a special shareholders meeting for Sept. 10 in Harvey to consider an agreement calling for exchange of all its assets for shares of Allis-Chalmers on the basis of one share of the latter's common stock for each 2 1/16 shares of Buda common, of which 411,498 are outstanding. As of June, Allis-Chalmers had 3,059,069 shares outstanding.

Canada Creosoting Co, Ltd, recently held open house at its Trenton, Ont., wood treating plant to mark the processing of the first of about 50,000 poles to be preserved with pentachlorophenol (penta) for Bell Telephone Co of Canada. The plant, which has a new steam plant under construction, contains two treating cylinders 132 ft long and 7 ft in diameter, each with a capacity of about 30,000 board feet, or 125 poles per charge.

General Electric Co's Power Transformer Department at Pittsfield, Mass., will begin construction in October of an 80 by 210-ft addition to its present 1,000 ft long transformer tank shop. Purpose of the expansion, which will be completed next spring, is to increase production in the large transformer sizes. . . . GE is also planning a $3,500,000 product development laboratory in Schenectady, N. Y. It will be used in improving design of steam turbine components. Construction begins this month under contract with Ebasco Services, Inc.

SALES ASSIGNMENTS

Company Staffs

Elliott Co, Jeannette, Pa., has appointed W. S. Carlson, formerly in the Duluth office, manager of the Minneapolis district office. H. D. Mateffy has been named branch manager of the Duluth office. M. L. Hiller, who has been a field engineer in the Washington, D. C. district office, has been made district manager. The firm's Tulsa (Okla.) district office is now located at 910 Petroleum Bldg.

Harnischfeger Corp, Milwaukee, has named Arch S. James as hoist sales engineer in its St. Louis office.

Colorado Fuel & Iron Corp, New York, has named Ford L. Brooke district manager of its newly opened New Orleans (La.) district sales office and warehouse. Brooke formerly handled sales of wire rope for Colorado F&I in Louisiana.

MEETINGS CALENDAR

***Public Information Program**
Inter-Regional Committee, Blackstone Hotel, Chicago, Sept. 1; West North Central Region, River Inn Hotel, Fergus Falls, Minn., Sept. 24; East North Central Region, Columbus, Ohio, Sept. 25; Mid-Atlantic Region, Baltimore, Md., Sept. 30; Steering Committee, Edgewater Beach Hotel, Chicago, Oct. 21; Workshop Conference, Edgewater Beach Hotel, Chicago, Oct. 22-23.

***American Institute of Electrical Engineers**
Pacific General Meeting, Hotel Vancouver, Vancouver, B. C., Sept. 1-4; Middle Eastern District Meeting, Daniel Boone Hotel, Charleston, W. Va., Sept. 29-Oct. 1; Conference on Application of Motors to Air-Moving Equipment and Symposium on Induction Motors, Hotel Van Orman, Fort Wayne, Ind., Oct. 6-8; Fall General Meeting, Muehlebach Hotel, Kansas City, Mo., Nov. 2-6.

Edison Electric Institute
Commercial Sales Section Committees, EEI headquarters, New York, Sept. 3-4; EEI-AGA Accounting Division Organization Meeting, Hotel Statler, Detroit, Sept. 15-18; Accident Prevention Committee, Radisson Hotel, Minneapolis, Sept. 21-22; Prime Movers Committee, Detroit, Oct. 5-6; Transmission-Distribution Committee, Hotel Nicollet, Minneapolis, Oct. 8-9; Industrial Relations Committee, Fall Round-Table Conference, Sheraton Hotel, Chicago, Oct. 12-14; Meter-Service Committee, William Penn Hotel, Pittsburgh, Oct. 19-21; Electrical Equipment Committee, Jung Hotel, New Orleans, Nov. 2-3.

Illuminating Engineering Society
National Technical Conference, Hotel Commodore, New York, Sept. 14-18.

Northwest Public Power Association
Accounting Section, Monticello Hotel, Longview, Wash., Sept. 17-18.

Public Utilities Association of Virginias
Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va., Sept. 17-20.

Maryland Utilities Association
Fall Conference, Cavalier Hotel, Virginia Beach, Va., Sept. 18-19.

Rocky Mountain Electrical League
50th Annual Fall Convention, Broadmoor Hotel, Colorado Springs, Colo., Sept. 20-23.

National Association of Railroad and Utilities Commissioners
Hotel Roosevelt, New York, Sept. 20-26.

Instrument Society of America
8th National Instrument Conference-

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Exhibit, Sherman-Morrison Hotels, Chicago, Sept. 21-25.

International Association of Electrical Inspectors
Silver Jubilee Meeting, Edgewater Beach Hotel, Chicago, Sept. 21-26.

Electric Lines Club of New England
Fall Meeting, University Club, Boston, Sept. 23.

New England Meter Engineers
Fall Meeting, Casco Lodge, Casco, Me., Sept. 24-25.

National Electrical Industries Show
Sponsored by Eastern Electrical Wholesalers' Association, 69th Regiment Armory, New York, Sept. 29-Oct. 2.

Great Lakes Power Club
Plankinton House, Milwaukee, Wis., Oct. 1-2.

Pennsylvania Electric Association
Fall Meeting, Relay Committee, Irem Temple Country Club, Dallas, Pa., Oct. 1-2; Joint Meeting of Transmission-Distribution Committee and Electrical Equipment Committee, Abraham Lincoln Hotel, Reading, Pa., Oct. 8-9; Meter Committee Fall Meeting, Brunswick Hotel, Lancaster, Pa., Oct. 22-23.

Southeastern Electric Exchange
Fall Meeting, Engineering-Operation Section, Carolina Hotel, Pinehurst, N. C., Oct. 1-2; Accounting Conference, Battery Park Hotel, Asheville, N. C., Oct. 15-16; General Sales Conference, Atlanta Biltmore Hotel, Atlanta, Ga., Nov. 19-21.

Interstate Power Club
Hotel Martinique, New York, Oct. 5; Hotel Martinique, New York, Dec. 7.

American Society of Mechanical Engineers
Fall Meeting, Sheraton Hotel, Rochester, N. Y., Oct. 5-7; Annual Meeting, Statler Hotel, New York, Nov. 29-Dec. 4.

Electric League of Western Pennsylvania
4th Industrial Electric Exposition, William Penn Hotel, Pittsburgh, Oct. 6-8.

Indiana Electric Association
Annual Convention, French Lick Springs Hotel, French Lick, Ind., Oct. 7-9.

Association of Edison Illuminating Companies
Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va., Oct. 8-10.

National Association of Electrical Distributors
Fall Meeting, Pacific Zone, Hotel del Coronado, Coronado, Calif., Oct. 11-14.

Iowa Utilities Association
Management Conference, Hotel Fort Des Moines, Des Moines, Oct. 12-13.

Electrical Association of Philadelphia
Biennial Electrical Progress Show sponsored by Manufacturers' Division, Convention Hall, Philadelphia, Oct. 13-15.

American Standards Association
4th National Standardization Conference and 35th Annual Meeting, Waldorf-Astoria, New York, Oct. 19-21.

***University of Texas**
Power Distribution Conference, Department of Electrical Engineering, Lower Colorado River Authority Auditorium, Austin, Oct. 19-21.

Oklahoma Utilities Association
Electric Light and Power Division, Eastern District, Vinita, Okla., Oct. 22; Western District, Norman, Okla., Oct. 23.

National Electrical Manufacturers Association
Annual Meeting, Haddon Hall, Atlantic City, N. J., Nov. 9-12.

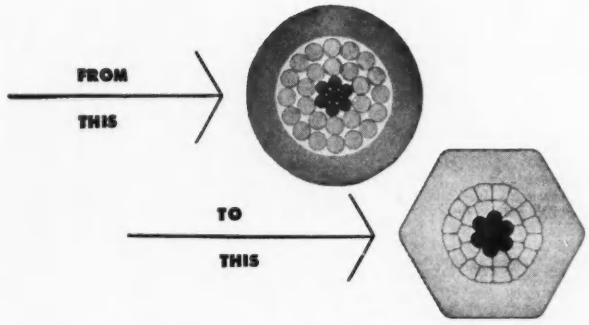
Wisconsin Utilities Association
Electric-Gas Section Convention, Schroeder Hotel, Milwaukee, Nov. 11-13.

Pacific Coast Electrical Association
Annual Hawaiian Conference, Honolulu, T. H., Nov. 19-20.

Public Utilities Advertising Association
Region Two Annual Meeting, Skytop, Pa., Dec. 10-11.

*Addition this week.

T & B METHOD



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TECHNICAL LITERATURE

Turbine Generators—A 20-pg booklet illustrating some 30 applications of "Industrial Turbine-Generators" is now available. Because requirements vary from applications where maximum conversion of heat energy to electrical power is most important to those in which process steam is of primary concern, the booklet describes the six principal types of industrial turbines. They are: non-condensing, non-condensing single-extraction, non-condensing double-extraction, condensing single-extraction, condensing double-extraction, and condensing. The booklet presents photographs and installation data on representative turbine applications. For a copy of this booklet, B-5418, write Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

Silver Brazing—"A Complete Guide To Successful Silver Brazing" is a new 48 pg booklet just released. The booklet is a guide available for all aspects of silver brazing applications and procedures. It provides correct answers to all general questions on low temperature silver brazing, brazing alloys, joint design, preformed brazing shapes, plymetals, fluxing, heating methods, cleaning and inspection. More than 50 drawings and charts are used to illustrate the text. Several of the reference charts have been found to be particularly useful in selecting specifications for silver brazing alloys, to check U. S. Government Specifications and for Conversion Data. Copies are available without charge to engineering and brazing personnel of industrial manufacturers, libraries and schools, upon request to The American Platinum Works, 231 New Jersey Railroad Avenue, Newark 5, New Jersey.

Standards—The following standards have just been published and are available from NEMA Headquarters: AEIC-EEI-NEMA Standards for Indicating Demand Registers, Publication No 130-1952 8 pages 50 cents per copy. American Standard Specifications for Radio Noise and Field Intensity Meters, 20 to 1000 Megacycles/Second, Publication No. 131-1952 8 pages 60 cents per copy. Standards for Direct-connected Steam Turbine Synchronous Generator Units (2000-10000 Kw. Inclusive), Publication No. TU4-1952 16 pages 75 cents per copy. Standards for Feeder Voltage Regulators, Publication No. FR1-1952 32 pages $3.00 per copy. Standards for Industrial Rectifier Units (Ungrounded 2-wire Service) (Sealed-tube Type). Publication No. 223-1952 16 pages $1.75 per copy. Standards for Mechanical-drive Steam-turbine Governors, Publication No. TU5-1952 8 pages 75 cents per copy. Standards for Mining Rectifier Units (Stationary and Portable), Publication No. 221-1952 16 pages $1.75 per copy. Standards for Silicone Varnished Glass Fabric, Publication No. VF5-1952 12 pages 75 cents per copy. Address inquiries to NEMA, 155 East 44th St, New York City, N. Y.

Bibliography of Resistance Welding—Resistance Welder Manufacturers Ass'n, 1900 Arch St, Philadelphia 3, Pa. The Bibliography has been prepared to present as completely and accurately as possible, a record of published technical articles on all phases of Resistance Welding. The list includes only those articles which have been published in the United States starting with 1946. However, some articles before 1946 are included because of their continued value and importance. Most would be considered out-dated and of little value. The Bibliography may be obtained at $1.25 per copy by addressing the above and asking for RWMA Bul. No. 17. Each listing includes a description of the article coverage. Address the Association Secretary if inclusion on their regular mailing list is desired.

Copper and Copper Alloys—Corrosion Resistance of—The American Brass Co, Waterbury 20, Conn. This Anaconda publication, B-36R, is an industry "first," and a result of twenty-seven years research and field study of the nature of corrosive attack on copper and copper alloys. The chemical and physical nature of corrosive attack in its various forms is explained. Also included in the 28-page booklet are a general discussion of corrosion resistance of copper alloys, metal selection charts and corrosion rating against 183 commonly handled industrial and natural materials, typical industrial uses of copper alloys, analysis and properties of copper alloys, properties and applications of copper-base welding rods, and a check list of information necessary to make proper choice of a metal for resistance to corrosion in a given environment. First published in 1952, this second edition is available without charge on request.

Fontana Project Hydraulic Model Studies—Published as Technical Monograph No. 68, this is a comprehensive account of all model investigations for the construction of Fontana Dam, from tests made at TVA's Hydraulic Laboratory at Norris, Tennessee. The report is 384 pages and contains 71 drawings, 53 tables, and 165 photographic illustrations. Coverage includes the general project description, Spillway Entrance tests, Friction Losses, Cavitation Test results, Spillway Outlet tests on 1:100 scale model, Howell-Bunger valve tests, Low-Level Outlet Structure, and the Emergency Spillway. The report is available at $5.00 from The Treasurer, Tennessee Valley Authority, Knoxville, Tennessee.

Modern School Lighting—Sylvania Electric Products Inc. announces their 16-page illustrated study under the title "Some Whys and Hows of Modern School Lighting." The statement that 80% of all school learning is gained through the eyes has guided the author, Willard Allphin in this study and review of the latest school lighting trends. New construction and the modernization of old buildings is covered under the topics: quantity and quality of light and brightness contrast, incandescent and fluorescent cost comparisons, lighting levels in classrooms, auditoriums, and halls; and correlations between light levels and the speed of learning. Write to Sylvania Electric Prod's. Co, 1740 Broadway, New York 19, N. Y.

Transformer Reference Book—Allis-Chalmers Manufacturing Co., Milwaukee 1, Wisconsin. This 170-page volume is available at $1.00 by addressing as stated. Thirty-three authoritative articles, originally published in the A-C Electrical Review, have been revised with new pictures and charts and cover such topics as "Combined Voltage and Base Angle Control Under Load," "Changing Taps Under Load," 'How to Parallel Regulators to Increase Feeder Capacity," 'Fundamentals of Audio Noise Measurements As Supplied to Transformers," "It's Simple to Overload Transformers Safely If You Know How," and "Trends in Power Transformer Application." Ask for "Transformer Reference Book" at $1.00. each.

Noise Measurement—A 120-page handbook has been made available by the General Radio Company to replace the well known "Noise Primer". Co-authored by Dr. A. P. G. Peterson of G. R. and Dr. Leo L. Beranek of M. I. T., the new Handbook of Noise Measurement covers thoroughly the measurement of airborne sounds, including definitions, standards, measuring equipment, procedures, and interpretation of results. Send $1.00 cash with order to General Radio Co, 275 Mass Avenue, Cambridge 39, Mass.

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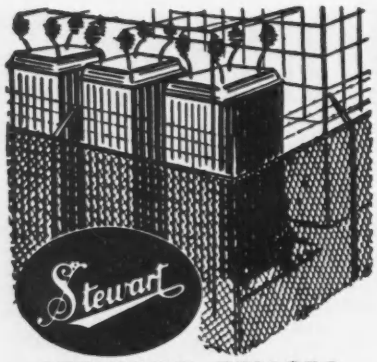

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WHAT THEY'RE SAYING

At Industry Meetings

Gas Turbine: New Electric Competitor

P. W. EMLER, director, industrial sales, American Gas & Electric Service Corp, at joint power sales conference, Industrial Power Committee, Southeastern Electric Exchange, and Industrial Power and Heating Section, Edison Electric Institute, Charleston, S. C.

There undoubtedly will be many improvements in the gas turbine in the future. Among these may be higher temperatures, the ability to use residual oil or coal as fuel, larger sizes, closed-cycle turbines, higher efficiencies and increased power with steam injection, free piston compressors, and certainly lower relative prices resulting from mass production.

The gas turbine will not now, nor is it likely to in the future, completely replace the gas engine, the diesel engine, or the steam turbine as prime movers.

The gas turbine has, however, certain characteristics which adapt it to some specific applications.

In those particular fields it is likely to be another source of competition to purchased electric utility service.

Utility Dividend Policies Plagued by Two Fallacies

W. F. STANLEY, financial vice president and secretary, Southwestern Public Service Co, at meeting of New York Society of Security Analysts

Two fallacies seem still to persist and confuse the thinking of some people on the question of dividend payout policy.

First, there's the school of thought which contends that since plowing back earnings adds to the company's income, and therefore to its per share earnings and to market value, a lower dividend payout is preferable.

Second fallacy is the assumption that dividend policy affects the common stock equity ratio.

What dividend policy decides is not how much shall be spent for construction, or what proportion of new capitalization shall be raised in the form of common stock—each of these amounts will be the same regardless of the payout exchange—but rather what part of the additional common stock equity shall consist of retained earnings and what part of proceeds of the sale of additional common stock.

Utilities Must Create Supply—and Demand

B. K. WICKSTRUM, vice president, Sylvania Electric Products, Inc, at Industrial Sales Conference, Pennsylvania Electric Association, Wernersville, Pennsylvania

In radio, and now in television, the utility industry never has been an important sales factor, although the amount of electricity used in radio and television sets is a sizeable consideration.

Some power companies have made a stab at television promotion, but the thing moved too fast for their kind of operation.

Maybe that's the way the utility industry wants it. Let others supply the demand for equipment of one kind or another and the utility will supply the energy. I can see some short term economic advantages in that kind of operation but I can't see the leadership that meant so much to the electrical industry in years gone by.

Residential Lighting Lags Behind Other Markets

WILLIAM H. ROBINSON, JR., manager of advertising, General Electric Co's Lamp Division, at annual conference of International Association of Electrical Leagues, San Francisco

Despite the concentration of our effort in the industrial and commercial fields, to the almost complete neglect of residential lighting, total electricity consumption for lighting in homes has increased at an even faster pace than those recorded in the other markets.

Even with this rapid progress, home lighting has actually lagged behind the other markets when we compare the results secured with the opportunities it offers. In fact, one of our recent surveys indicated that at the present rate of improvement, it would take residential lighting no less than 100 years to reach the standards now prevailing in many stores and offices.

Wherever *reliable* sensitive control is required

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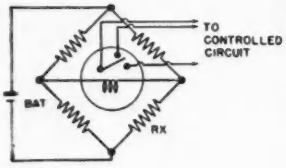
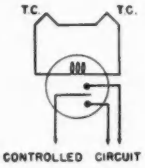
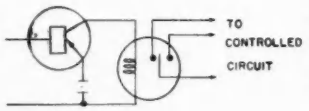
Temperature Control and Protection



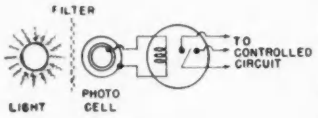
Resistance Selection



Temperature Differential Control



Transitor Selection



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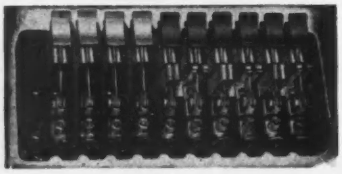

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CATALOGS • BULLETINS

● **IMMERSION HEATERS:** A new electric immersion heater catalog that features a section of application data for calculating the power requirements for heating processing tanks has been prepared by the Cleveland Process Co. The data simplifies the problem of estimating heat losses, determining the correct kw needed, and selecting proper heater size for tank capacity. With these factors accurately determined, it is an easy matter to establish the most efficient and economical immersion heater installations. A copy of the Clepco-Glorod Immersion Heater Catalog with power calculating data may be had by writing to Cleveland Process Co, 7016 Euclid Ave, Cleveland 3, Ohio.

● **RELAYING:** A new and expanded edition of "The Art Of Protective Relaying," which explains the broad principles of modern practice in protective relaying of power apparatus, has been announced as available from the General Electric Co, Schenectady 5, New York.

The 72-page, illustrated booklet (GET-1768A) contains information on types of relays used for protecting such apparatus as generators, transformers, transmission lines, etc. It outlines procedures used in evaluating power apparatus and system characteristics to determine proper application and settings of relays, and also gives a complete listing of available relays with references to detailed descriptive literature.

● **TRENCH DIGGERS:** The Cleveland Trencher Co recently issued an 8-page bulletin on the improved Cleveland Model 92 which is now equipped with a 4-speed motor transmission. The new unit doubles the number of digging wheel and traction speeds previously available in the 92. Highly maneuverable and mobile, the compact but husky Model 92 is designed for use on cramped city and suburban jobs. The 48 evenly graduated speed combinations give 30 or more usable digging speed combinations providing the right speed and power for every type of soil and digging conditions. Complete dimensions and specifications are given, including a table of optional digging widths. Copies of the Cleveland Model 92 Bulletin may be obtained without obligation by writing on business stationery to the Cleveland Trencher Co, 20100 St. Clair Ave, Cleveland 17, Ohio.

● **CIRCUIT BREAKERS:** The application of AB-1 circuit breakers to reduce downtime and maintenance is discussed in a booklet available from the Westinghouse Electric Corp. Actual cases—with savings—show how the replacement of fused devices by AB-1 circuit breakers results in improved continuity of operation. Complete design and operating details are provided, and typical applications for each of the seven different types of enclosures are given. A basic selection-data chart for general purpose NEMA 1A sheet steel enclosures is provided as well as a downtime cost comparison sheet for circuit protection. For a copy of this booklet, B-5456, write Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pennsylvania.

● **CENTRIFUGAL PUMPS:** The complete line of SESC (Standard End Suction Centrifugal) pumps is described in bulletin W-300-B4 now available. Capacities up to 2500 GPM at Total Head up to 500 ft are provided by six types of pumps. For the bulletin and additional information, direct requests to Worthington Corporation, Centrifugal Pump Division, Harrison, New Jersey.

● **MULTIPURPOSE STEEL FRAMING:** Storage racks, scaffolding, electrical framing, lighting fixture supports can be built without drilling, welding, or special tools. To obtain 4-page bulletin write American Steel and Iron Works, Div. A. F. Anderson Iron Works, 58th & South Lowe Ave, Chicago 21, Illinois.

● **OIL TIGHT PUSH-BUTTON UNITS:** The G-E line of oil tight push-buttons, with special emphasis on color ring identification and building-block combinations, is described in a new two-color publication announced as available from the General Electric Company, Schenectady 5, N. Y. Designated as GEA-5779, the eight-page bulletin uses more than 35 photos and drawings to illustrate the flexibility and maintenance, and the various types of units and switches that are available. Also included are ratings and dimension diagrams.

● **GAS TURBINES FOR MECHANICAL DRIVES:** A 24-page booklet describes four types: 1800-hp, simple open-cycle; 5000-hp, compound open-cycle with regenerator; 5300-hp compound open-cycle; and 7000-hp simple open-cycle. The twelve factors to be considered in selecting a gas turbine power unit for mechanical drive service are listed along with sample calculations for the use of curves. Write for booklet B-5859 to Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

● **EXPLOSIVE MIXTURE ALARM:** Scanning type, multi-point J-W Combustible Gas Alarms for industrial protection are described in a new leaflet, Form RV 453. The means by which samples are continuously drawn to the analyzer from remote points and measured for combustibility on a 30-second cycle are described. For bulletin and further details write Johnson-Williams, Ltd., 2738 Third St, Palo Alto, California.

● **DEHUMIDIFICATION EQUIPMENT:** Information bulletin 374 covers the problems, the answers, and the equipment for humidity control. Refrigerant and chemical types of units are offered for both industrial and home requirements. Copies are available without obligation from Abbeon Supply Co, 179-15 Jamaica Ave, Jamaica 32, New York.

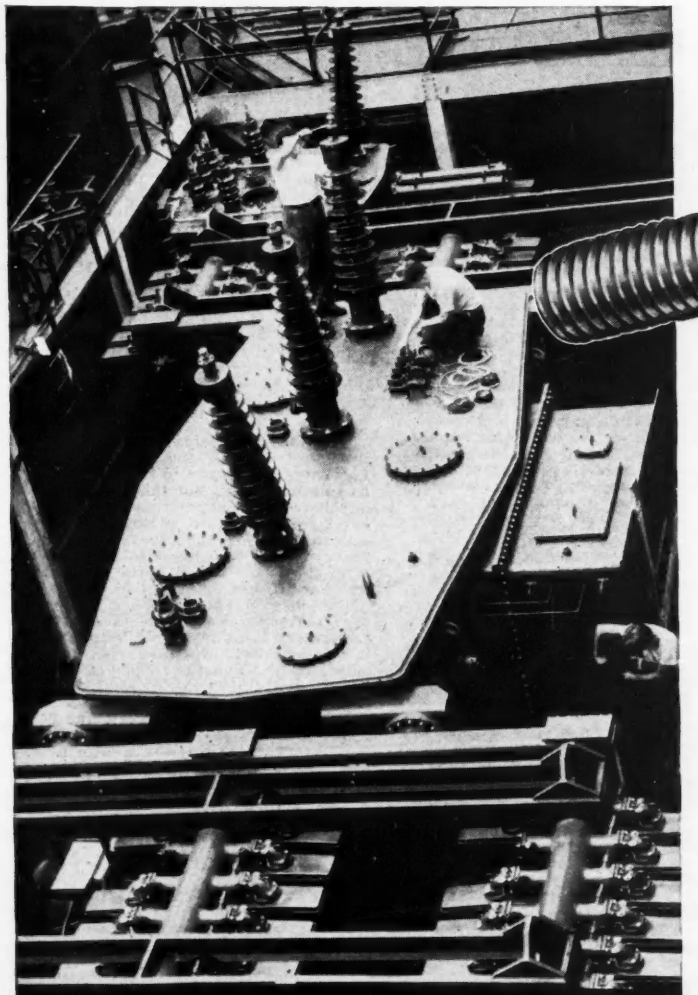
● **ELECTRIC HEAT-TREATING FURNACES:** A new 8-page, two-color brochure containing a photo portfolio of outstanding installations of heat-treating furnaces is available from Lee Wilson Contracting Co, 20005 West Lake Rd, Cleveland 16, Ohio. Available also with oil and gas firing, 14 types, including roller hearth, chain conveyor, belt conveyor, overhead slot-in-roof, car bottom pit, strand heating and aluminum soaking pit are illustrated. Design and engineering services for the furnaces are also offered.

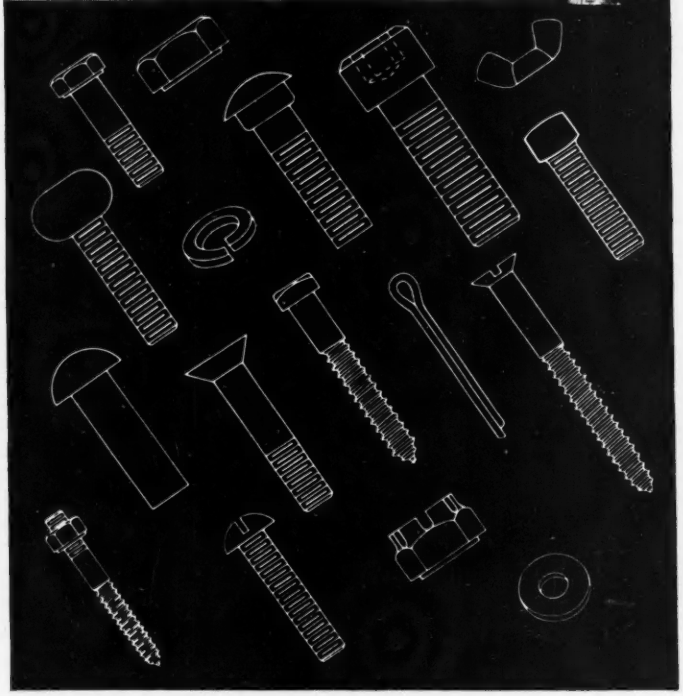
● **HIGH-SPEED GROUNDING SWITCH:** Catalog 158, page 1 & 2 covers 1-, 2-, and 3-pole styles, 69 kv or 115 kv. For details on this unit, designated type FG, write to Pacific Electric Mfg. Corp, 5815 Third St., San Francisco 24, Calif.

● **OVERHEAD TRAVELING CRANES:** Bedford Foundry & Machine Co, Inc, Bedford, Ind. announces a complete catalog including specifications of Bedford's engineered Standard, Industrial, Low-Head, Grab-Bucket, Mill & Gantry type cranes in capacities from 5 to 350 tons or larger.

● **WEATHER RESISTANT LIGHTING FIXTURES:** Explosion-proof and weather resistant fixtures are covered in Bulletin SEC-K, 4 pages, including component description performance data, and methods of installing or relamping. Write Grouse-Hinds Co, Wolf and Seventh North Sts, Syracuse 10, N. Y.

● **PRESSURE AND VACUUM GAUGES:** New 32-page Cat 7001 covers indicators, recorders, pneumatic and electric controllers and pneumatic transmission. Write to Station 64, Minneapolis-Honeywell Regulator Co, Industrial Division, Wayne and Windrim Aves, Philadelphia 44, Penna.





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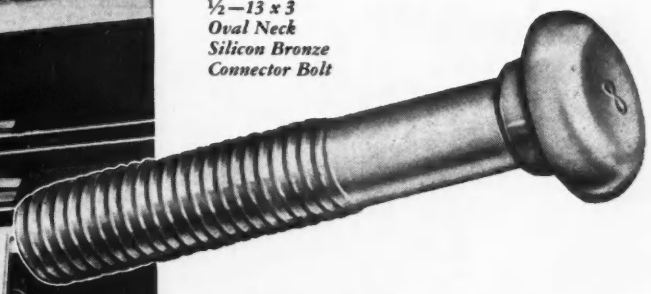

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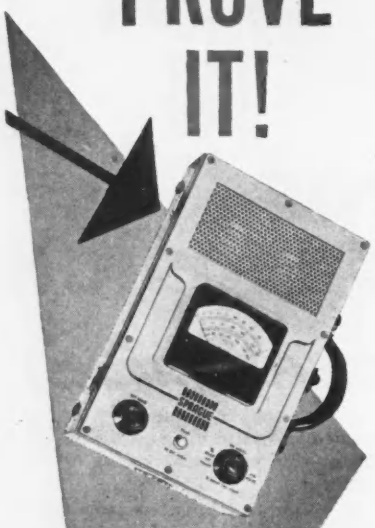

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BOOK REVIEWS

Costs

Estimating Construction Costs. **By R. L. Peurifoy. Published by McGraw-Hill Book Co, New York 36, N. Y. 315 pages, illustrated. Price $5.50.**

Written as a college text this book nevertheless has specific value for an engineer charged with cost estimation, particularly in fringe branches of the art. There is little specifically electrical here but plenty on methods for predetermining costs of transporting and handling equipment and materials, excavation, foundations, structures of stone, concrete, brick, timber and steel. Many will find the author's unit values directly useful despite his warning that they are introduced primarily for illustration purposes and not universal or official. His by-the-hour approach for both equipment and labor is especially informative as are his handling of depreciation, maintenance, interest, insurance, etc. Tables cover compensation, insurance charged, and daily rental rates for a wide variety of equipments.

Galvani's Experiments

Commentary on Electricity. **Luigi Galvani. Translated by Robert Montraville Green. Published by Elizabeth Licht, 30 Hillside Ave, Cambridge 40, Mass. 100 pages. Illustrated with reproductions of original plates. Price $4.**

Galvani's account of his experiments with frogs and other animals from which stemmed so much of later increase in knowledge of electricity is here to be read in English for the first time. Translations from the Latin of scientific communication of the 18th century have been available in European languages for many years, but, curiously enough, his "Commentary" had never been turned into English. Additional material in the book includes a dissertation on Galvani's work by his nephew, Giovanni Aldini, and a letter from Bassano Carminati with reply by Galvani.

To read this book is to get a revealing picture of the painstaking, checked, rechecked and counter-checked experimentation that became the very foundation of electrical engineering, the concept of current, as distinct from static, electricity. Reading, one shares with this professor of obstetrics at the University of Bologna his excitement as, bit by bit, he uncovers the secrets of nature and tells of them in his modest way.

Electrical Equipment

Electro-Magnetic Machines. **By R. Langlois-Berthelot. Published by MacDonald & Co, Ltd, London W 1, England. 532 pages, illustrated. Price 65 shillings.**

Devoted to rotating equipment and transformers which it groups as electromagnetic machines, the book comprises six distinct parts. The first is a general presentation of the properties and application of various types of equipment. It serves as an introduction for more intensive subsequent treatment.

Part two presents the scientific background of electricity and magnetism in relation to electrical machinery. It lays the groundwork for the third part in which design problems and materials are discussed.

The author then turns to operating considerations, devoting part four to specifications, standardization, acceptance testing, and characteristics. Part five briefly reviews harmonics, unbalanced loading and transients. And the sixth part discusses relationships between physical concepts and practical design. More or less elementary related material, such as complex quantities, standard notations and units, and electric circuit theory, are collected in a short appendix.

Translated from the French and revised by Lt. Col. H. M. Clarke, this book is an unusually complete exposition of the theory, design and operation of electrical machinery. Although a more extensive index would enhance its value, the utility engineer who must periodically refresh his knowledge of such equipment should benefit by its logical presentation.

Electronics

Index: MIT Radiation Laboratory Series. **By Keith Henney. Published by McGraw-Hill Book Co, New York 36, N. Y. 160 pages. Price $4.50.**

The library of microwave and radar technology known as the MIT Radiation Laboratory Series ran to 27 volumes. Each had its own index but this general index is wholly independent of the 27 independent indexes. Further, it was prepared by an experienced handbook editor. It therefore is a peculiar avenue to finding what is in the whole series, particularly those items which are topmost today.

But that is not all. Four men who were really the creators of the Radiation Laboratory in as many prefaces tell how it was conceived, organized, operated and terminated. Vannevar Bash from the NDRC and OSRD angle, Karl Compton from the MIT angle, Lee DuBridge from the Radiation Laboratory angle and L. N. Ridenour from the Series angle. These few histories in themselves are worth having if only to show how a democracy can muster talent almost overnight to create a whole new technology that stopped three dictatorships dead in their tracks.

Superconductivity

Low-temperature Physics. **By C. F. Squire. Published by McGraw-Hill Book Co., New York 36. 244 pages, illustrated. Price $6.50.**

Treatment here is dominantly mathematical and thermodynamic. Electrical engineering interest will likely be in the discussion of superconductivity, magnetic behavior and dielectric characteristics at temperatures near the absolute zero. Only metals in limited zones of the periodic array show the infinite conductivity and strangely aluminum is one of them but copper is not. The author shows how magnetic fields have facilitated attaining a temperature only 0.0004 K from the absolute zero. Discussion of dielectrics is confined largely to certain titanates.

Electronic Motion

Fundamentals of Electronic Motion. **By W. W. Harman. Published by McGraw-Hill Book Co, New York 36, N. Y. 319 pages, illustrated. Price $6.50.**

Actually this is a mathematical analysis of vacuum tubes, including cavity resonators and magnetrons, so basic as to open the door to new performance and application. Treatment is not however directed so much at performance as at an understanding of the behavior in terms of electron motion under the influence of electric and magnetic forces. On the way there is discussion of space charge, motion in time-varying fields, traveling-wave amplification, magnetron amplifiers. A final chapter takes a ride on an electron to explore the area of relativistic electrodynamics.

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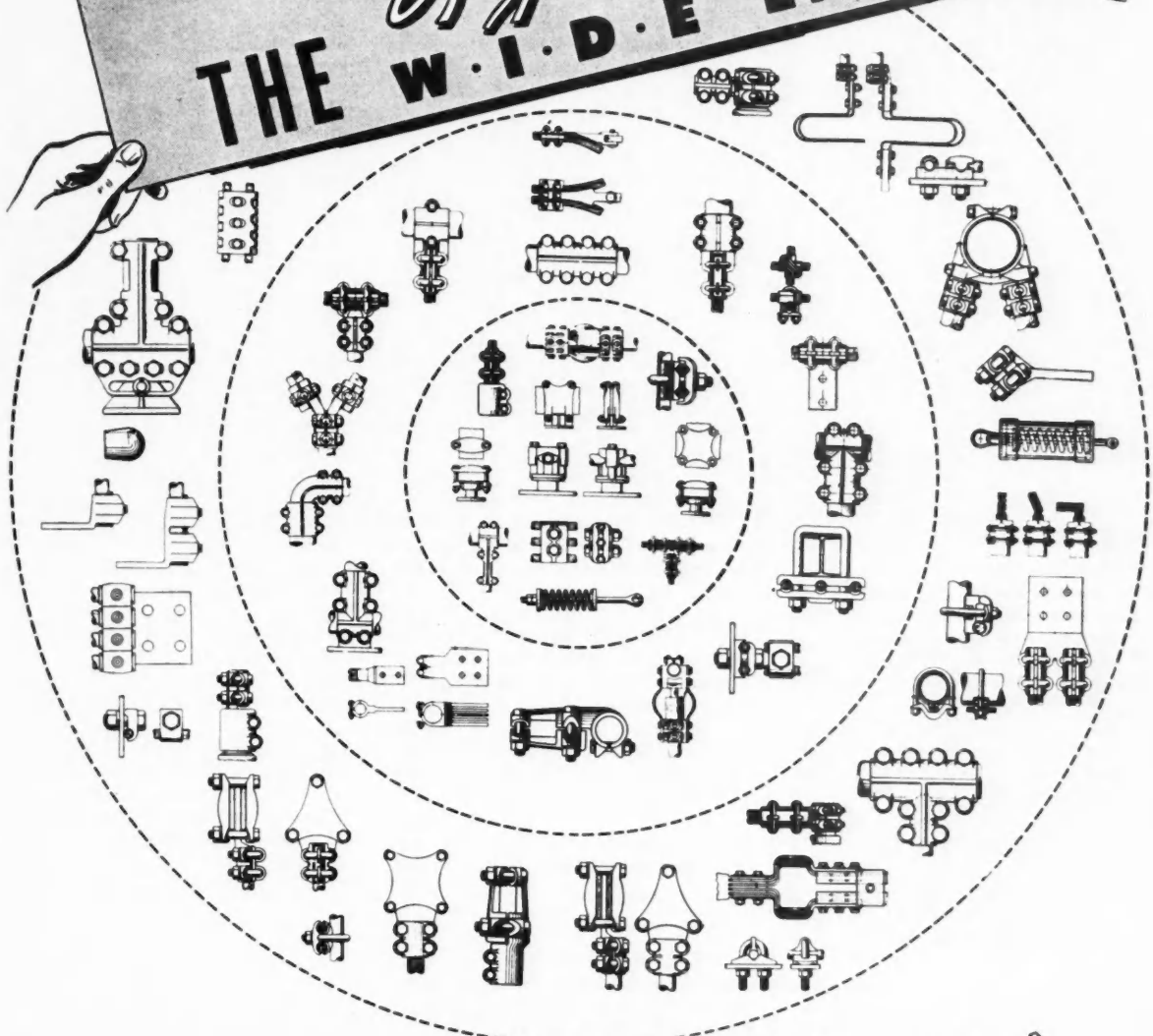

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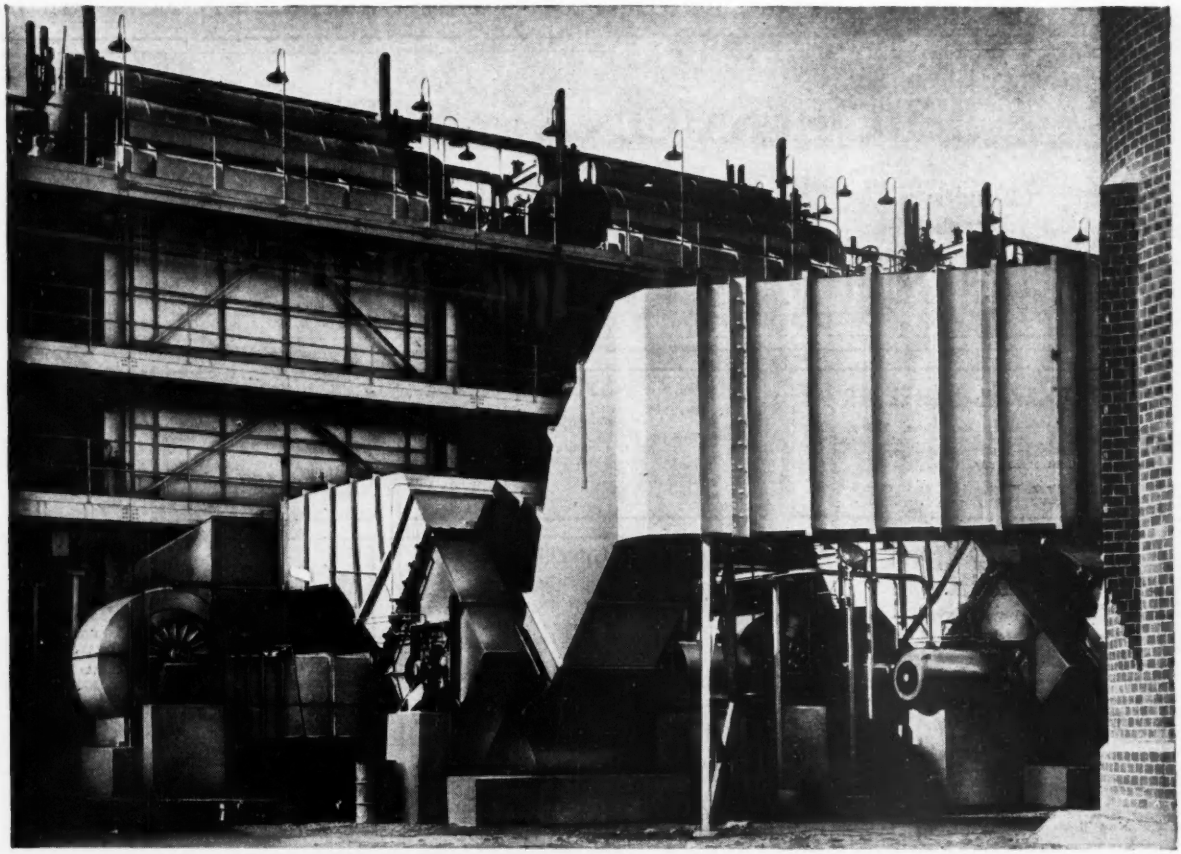

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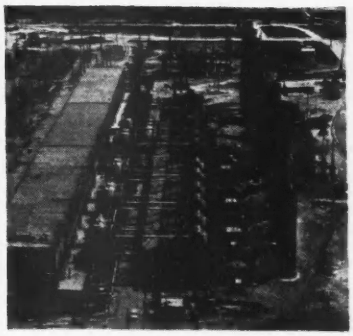

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Sales Representative

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Here, what we believe, is an outstanding position for a man now contacting utilities and municipal power plants.

We are a highly respected manufacturer of switchgear equipment, unit substations, specialty control boards, and metal fabrications for the electrical industry.

This opening, therefore, requires that you have experience in contacting the purchasing and engineering departments. The territory assigned will depend upon your experience and ambition. However it will include some part of Illinois, Wisconsin, Indiana, Ohio, and Michigan.

Your remuneration will be on the basis of commission with a drawing account. . . . If interested, please write to

SW-8941, Electrical World
520 N. Michigan Ave., Chicago 11, Ill.

ELECTRICAL ENGINEER ESTIMATOR

For electric generating stations, substations, transmission and distribution

Experienced Estimator required with at least ten years preferably in connection with estimation of costs in public utility generating stations, substations, transmission lines and distribution by service organization . .resenting Public Utilities in eleven Latin American countries. In letter of application state age, education, experience and salary expected. Location New York; some travel, Spanish desirable, but not necessary.

P-8922, Electrical World
330 W. 42 St., New York 36, N. Y.

RELAY ENGINEER

Electric utility serving in the East desires a graduate electrical engineer experienced in testing and inspecting relays, carrier current and supervisory equipment. Should be familiar with short circuit calculations and A.C. and D.C. boards. Salary depending upon experience and ability. Applicants please give age, education and experience.

P-8844, Electrical World
330 West 42nd Street, New York 36, N. Y.

TRANSFORMER ENGINEER

Thoroughly familiar with all phases of design and construction of oil-filled transformers through 10,000 KVA. Write giving full background, experience, education, and any other pertinent data. Excellent future possibilities with big and growing firm outside New York City greater New York area.

P-8870, Electrical World
330 W. 42 St., New York 36, N. Y.

WANTED

MECHANICAL ENGINEERS

Established consulting firm, New York area, desires Mechanical Engineers capable supervising starting, testing, operating and correcting troubles of steam electric station equipment. Plant betterment work involving considerable travel. Technical education and plant operating or betterment experience required. State education, experience and salary desired.

P-8514, Electrical World
330 W. 42 St., New York 36, N. Y.

IF

IF you are a graduate electrical engineer

IF you have had experience with a utility company, or

IF you are familiar with the application of transmission and distribution equipment on power systems and are between 30 and 45 years of age

IF you would enjoy calling on regular established utility accounts as a resident Field Engineer

IF you are interested in a creative technical sales career, and

IF you would like to make a change but feel that your next job should be your last job

WE WOULD LIKE TO TALK TO YOU!

We are one of the leading manufactures of transmission and distribution equipment in this country; progressive, growing and offering practically unlimited opportunity to the individuals selected for positions as Field Engineers in the East or North Central U. S. All of our top executives have come up through the ranks.

Remuneration is on a salary basis plus an annual bonus and profit sharing plan. Liberal hospitalization and group insurance programs. Automobile furnished and maintained by the Company; all travel expenses paid.

Send resume of education and business experience to

P-8915, Electrical World, 520 N. Michigan Ave., Chicago 11, Ill.

CHICAGO DISTRICT SALES MANAGER

Wanted by long-established, progressive, expanding mid-west manufacturer of industrial apparatus, sold against keen competition to all classes of trade. This is not a desk job. Territory includes northern Illinois and a portion of northern Indiana. Small technical field sales force. Compensation will be unusually substantial, and will be made up of base salary plus a bonus; liberal guarantee will be offered for the first year.

Candidates MUST be graduate electrical engineers or possess equivalent practical experience, and have *substantial responsible sales experience in dealing with industrial technicians and executives.* Current knowledge of Chicago area industrial market very desirable but not essential. Prefer man now employed and professionally active, and well known in the electrical engineering or industrial field, age 35-45.

This position is definitely worth investigation on the part of qualified, top flight men.

Replies (*full* details, please) will be treated in full confidence by reputable management consulting firm. Address:

GRIFFENHAGEN & ASSOCIATES
333 No. Michigan Ave. Chicago 1, Ill.
Attention: Mr. Larson

RATE ENGINEER

For permanent position with responsible service organization; location New York. Good opportunity for qualified man with sound knowledge of Public Utility economics and operations and broad experience in field surveys, analysis, design and application of electric rates. Preferred age 30-45. Must be willing to undertake some travel in Latin America. Knowledge of Spanish helpful but can be acquired after employment. State age, education, experience, personal particulars and salary desired in first letter.

P-8926, Electrical World
330 W. 42 St., New York 36, N. Y.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

FIELD SUPERINTENDENT for field organization of specialized contractor with crews throughout the country. Must know electrical hazards and climbing. Salary $9,000 plus profit-sharing plan and car. Write qualifications to P. O. Box 905, Station C, Buffalo 9, N. Y.

PRODUCT DESIGN—Engineer—Manufacturer of high voltage electrical equipment in Southeast Area. Must be well experienced in mechanical design and preparation of shop detail drawings. Should be familiar with foundry and machine shop practices. Electrical product design desirable but not essential. State qualifications and salary expected. P-8869, Electrical World.

POSITIONS WANTED

ELECTRICAL ENGINEER, age 44, experienced in design of distribution, sub-transmission, and industrial power systems, but primary interest is in operation, maintenance and construction. Over 10 years experience in public utilities, and 2 years in General Engineering. Registered Professional Engineer. Available in late September. PW-8814, Electrical World.

EXPERIENCED SWITCHBOARD Operator would like operating job in central or substation. PW-8267, Electrical World.

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2670 Clybourne Ave. Chicago 14, Illinois

U. S. Government

DEPARTMENT OF THE INTERIOR, Bureau of Reclamation. Sealed bids (Invitation No. DS-4011) will be received at Denver, Colorado, until September 24, 1953, for furnishing two 8,000/10,000-kva, 110,000- to 69,000/39,840-volt, 3-phase, oil-immersed, class OA/FA, outdoor power transformers, with tank-mounted arresters; and one 12,500-volt, 3-phase, interconnected star, 91-ampere, oil-immersed, self-cooled, outdoor grounding transformer for Maricopa Substation, Davis Dam Project, Arizona. Delivery is desired within 300 and 600 days. For particulars, address Bureau of Reclamation, Building 53, Denver Federal Center, Denver, Colorado.
W. A. DEXHEIMER, Commissioner

DEPARTMENT OF THE INTERIOR, Bureau of Reclamation. Sealed bids (Invitation No. DS-4008) will be received at Denver, Colorado, until September 15, 1953, for furnishing three 20,000/26,667-kva, 220,000- to 115,000 grounded wye-volt, 1-phase, class OA/FA (with provision for future addition of second-stage supplemental cooling for 33,000-kva), outdoor autotransformers, with 13,200-volt tertiary winding and with arresters for Sioux City Substation, Iowa, Missouri River Basin Project. Delivery is desired within 720 days. For particulars, address Bureau of Reclamation, Building 53, Denver Federal Center, Denver, Colorado.
W. A. DEXHEIMER, Commissioner

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SUBSTATION EQUIPMENT

TRANSFORMERS

Qu.	KVA	MFR.	VOLTAGE
4	2500	Mol.	69000—13800
4	500	Pitts.	66000/33000—13200/23000 Y
4	500	West.	69000—6900
3	400	G. E.	66000/33000—2300/4160
3	200	Pitts.	66000—2300
4	150	West.	44000/33000—2300/6900
3	75	West.	44000—7200/12470 Y
4	5000	G. E.	40935/70900 Y—14500
3	5000	G. E.	38100/66000—6600
3	3333	G. E.	33000/11000—2400/7200
4	500	G. E.	33000—7200/12470 Y
4	333	G. E.	33000—7200/12470 Y
3	250	Mol.	33000—13800/23900 Y
3	200	A. C.	34500—2400/7200/12470 Y
3	100	West.	33000—240/480 NEW
3	75	Wag.	33000—7200/12470 Y
4	1500	A. C.	25400/44000 Y—6900/13800
4	450	A. C.	25410/44000 Y—13280/23000
3	100	G. E.	22000—7200/12470 Y
3	50	G. E.	22000—2300
1	5000	Pitts.	13200—4600, 3 ph.
1	600	Stand.	13200—2300, 3 ph.
1	450	Penna.	13200—2400, 3 ph. ASKAREL
3	250	West.	13800—480/240
3	250	Pitts.	7200—220/440
3	100	G. E.	7200—240/480
3	75	G. E.	7200—240/480
3	150	Wag.	6900—2300
3	37½	G. E.	6900—230/460
4	150	G. E.	4800/2400—240/120
2	100	G. E.	4800/2400—480/240
3	400	G. E.	2400/4160 Y—480
3	333	G. E.	2400/4160 Y—240/480
3	250	G. E.	2300/4000 Y—115/230
3	200	West.	2400—240/480
3	150	West.	2400—230/115
1	100	G. E.	2300—575, 3 ph.
3	75	A. C.	2400—240/480
6	50	West.	2400—114/228 DRY TYPE

INDUCT REGULATORS—OUTDOOR

1—140 KVA G. E. 200 A. 4000 V. 3 ph.
2— 83 KVA West. 200 A. 2400 V. 3 ph.
3— 48 KVA West. 200 A. 2400 V. 1 ph.
8— 36 KVA West. 150/300 A. 2400 V. 1 ph.
2— 36 KVA G. E. 75/150 A. 4800 V. 1 ph.

CIRCUIT BREAKERS

4— 800 A. 132 KV West. G-222A-2500
2— 400 A. 37 KV G. E. FHKO-136-350 MVA
1—1200 A. 15 KV G. E. FKO-139-350 MVA
4— 600 A. 15 KV G. E. FHKO-139-750 MVA

BREW, WOLTMAN & CO., INC.
52 Church St., New York 7, N. Y.

TRANSFORMERS

FOR SALE

3—1000 KVA Mol 11500-2400/4160Y
3— 500 KVA G-E 22000-2300/4000Y
3— 333 KVA W-H 13200-2400/4160Y
3— 333 KVA W-H 6600-2300
3— 333 KVA Mol 7200/12470Y-2400/4160Y
3— 250 KVA G-E 6600-575
3— 150 KVA G-E 19050/33000Y-2540/4000Y
2— 150 KVA G-E 6900-230/460
3— 100 KVA G-E 33000-6900/11950Y
3— 100 KVA G-E 4000-115/230
3— 50 KVA A-Ch 33000-6900/11950Y
3— 50 KVA A-Ch 33000-2400/4160Y

Many other items in stock.

TRANSFORMERS WANTED

Reliable rewind and repair service on all makes of transformers

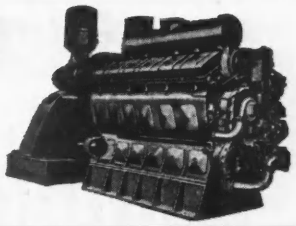
THE ELECTRIC SERVICE CO.
CINCINNATI 27, OHIO
40 Years Dependable Service

TURBO GENERATOR

Available Immediately
7500 KW G.E. Co.
180 P.S.I.—525°F Total Temp.
3 phase 60 cycle 2300 volt
With Surface Condenser
GOOD CONDITION

Union Electric Co. of Missouri
315 N. 12th Blvd. St. Louis 1, Mo.

DIESEL POWER



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UNIT CAPACITIES—10 TO 2475 KVA
A.C.—50 AND 60 CYCLES
• ALSO D.C. UNITS

A PARTIAL LISTING OF OUR INVENTORY

KW	Make	Model	HP	RPM	KW	Make	Model	HP	RPM
1980	Nordberg	TS-217	2800	225	320	Enterprise	DSG-6	560	450
1136	Fairbanks Morse	38D	1600	720	300	General Motors	8-268A	450	1200
1100	General Motors	16-278A	1600	720	200	General Motors	8-268A	350	900
750	General Motors	12-567	1080	720	150	Worthington	CC-4	225	450
500	Baldwin	VO-8	750	514	150	Ingersoll-Rand	S-4	225	600
500	General Motors	8-278A	750	720	150	Buckeye	80	240	600
500	General Motors	8-567	720	720	100	Worthington	BB-5	150	600
480	Worthington	DD-8	700	360	100	General Motors	3-268A	150	1200
400	Ingersoll-Rand	S-8	600	720	60	General Motors	6-71	90	1200
350	Baldwin	VO-6	510	450	30	Internat'l Harvester	UD-14	45	1200

A. G. SCHOONMAKER COMPANY, INC.
DIESEL DIVISION, 50 CHURCH ST., NEW YORK 7, N. Y.

FROM AVAILABLE STOCK

TURBO GENERATORS IN STOCK

Q.	KW	Make	Desc.
1	—1000	G.E.	Non-Cond—190 lbs-2400-3-60
1	—1000	Moore	Condensing—Extraction—190 lbs., 2400-3-60—Surface Cond.
1	—750	G.E.	Condensing—265 lbs., 440-3-60 Built 1944
1	— 500	Moore	Non-Cond—150/200 lbs., 5/35 lbs. B.P., 480-3-60 Dir. Conn. Exciter
1	— 400	Westgh.	Non-Cond—125/150 lbs., 5/10 lbs. B.P., 240/480-3-60
1	— 300	G.E.	Non-Cond—150/175 lbs., 5/10 lbs. B.P., 480-3-60

FREQUENCY CHANGERS

Qu	Kva	Make	Cycles	Voltages
1	—12500	Whse.	25/60	13200 x 13200
1	—3750	G.E.	25/60	4150/2400 x 2400/4150
1	—3125	G.E.	25/60	4150/2400 x 2400/4150
2	—2500	G.E.	25/62½	2300 x 4160
1	—1250	G.E.	25/58.3	4400 x 2300
1	—625	A.C.	25/60	11000 x 2300

MOTOR GENERATOR SETS

3 ph, 60 cy.

Qu	KW	Make	Speed	DC Volts	AC Volts
1	—3000(3U)	G.E.	514	600	4000/13200
2	—2000	G.E.	450	250	2400
2	—2000	G.E.	514	600	6600/13200
1	—2000	G.E.	500	666 25 cy.	11000
2	—1750	G.E.	514	250	2400
1	—1500	C.W.	514	115	4000/13800
1	—1500	G.E.	720	600	13200
1	—1500	G.E.	600	600	2300/4150
1	—1000	G.E.	900	260	4100/6900
2	—1000	Whse.	900	600	2300/4150
1	— 750	Whse.	900	275	2300/4150
1	— 500	Whse.	1200	125/250	2300
1	— 500	Whse.	900	250	440
1	— 500	G.E.	720	125	2300

TRANSFORMERS—60 Cycle

KVA	Make	Type	Ph	Voltages
1—5000	Whse.	OISC	3	33000x26400/13200
1—2500	Whse.	OISC	3	26400/13200 x 480
3—1250	G.E.	HVDDJ		6900x550
1—1150	A.C.	OISC		3200x480/2400
3—1000	G.E.	HVDDJ	1	2200/480

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51 Howell St. Jersey City 6, N. J.

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TRANSFORMER

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667 KVA New, Gen. Elec., type H., O.I.S.C. transformer, sgle. phase, 33,480 v. primary, 480 v. secondary. 3-2½% taps, 6% impedance. Ser. #7384726

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CHICAGO Electric Co.

1324 W. CERMAK ROAD
CHICAGO 8, ILL.

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The following Electrical Equipment Available for immediate delivery

G. E.

2 Synchronous Motors 1250 Kva each 2,200 volts 240 R.P.M. with Switch board and switch.

1 Motor Generator Set G. E. Induction Motor 135 H. P. 2,200 volts 1175 R.P.M. with starting Compensator direct Coupled to G. E. D. C. Generator. Compound wound 125 volts 720 amps.

1 G. E. Induction Motor Slip Ring. 400 H.P. 2,200 volts, 588 R.P.M. Secondary volts 437 and Drum Controller.

Information:
P. O. Box 867 Monterrey, N. L. Mexico

J. L. HEMPHILL & CO.

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1606 53rd ST., NORTH BERGEN, N. J. N.Y.C. Tel. LOngacre 5-3227 N. J. Tel. UNion 3-7600

TRANSFORMERS

1—1500 KVA G.E., 3 Ph., 4150V. 2300V. Pyranol
2— 750 KVA G.E., 3 Ph., 4150V. 120/240V. sec.
2— 750 KVA G.E., 1 Ph., 4600V. 115/230
2— 400 KVA Pitts., 1 Ph., 2400/4800V. 240/480V.
3— 333 KVA Whse., 1 Ph., 2400V. 600 V. sec.
2— 300 KVA G.E., 1 Ph., 13200V. 220/440V.
1— 200 KVA G. E., 3 Ph., 2480-220 sec.
3— 200 KVA G.E., 1 Ph., 13200V. 440V.

SYNCHRONOUS MOTORS

1— 300 H.P., Elec. Mach., 720 RPM. 3 Phase 60 cyc., 2200V T E F Cooled Outdoor service.
1— 150 H.P., G.E., 1800 RPM. 220V. 3/60.
2— 150 H.P., Al. Chal. 360 RPM. 440V. 3/60.

MOTOR GENERATOR SETS

1—1000 KW Whse., 600 V. 720 RPM. 4000 Syn.
1—1000 KW G.E., 600 V. 514 RPM. 4000 Syn.
1—1000 KW Whse., 275 V. 720 RPM. 4000 Syn.
1— 200 KW Whse., 250V., 900 RPM. 4000V. Syn.
1— 150 KW G.E., 126/250V. 1200 RPM. 2300 Syn.
1— 100 KW G.E., 250V. 900 RPM. 2300V. Syn.

SLIP RING MOTORS

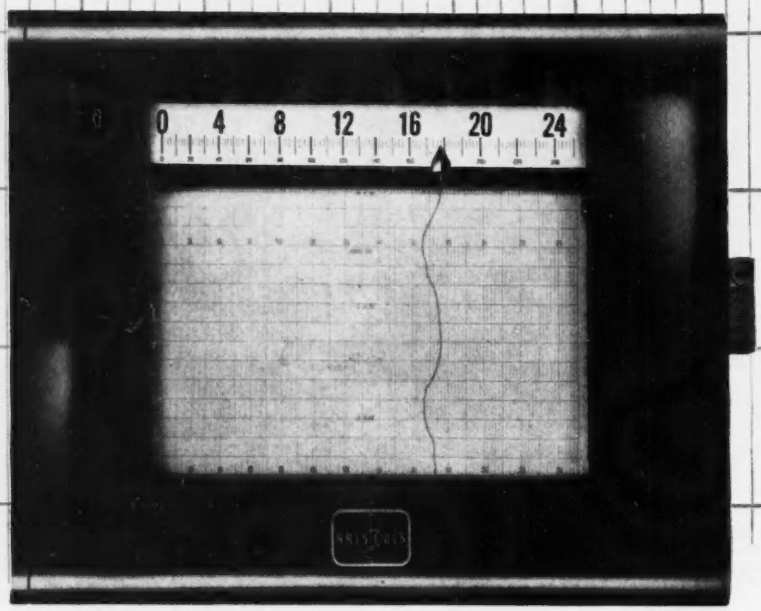
2— 500 H.P., G.E., M 1200 RPM 2400 V.
1— 400 H.P., West., CW. 460 RPM. 550V.
1— 250 H.P., West.,CW. 600 RPM, 440V.
1— 200 H.P., West., CW. 600 RPM. 440V.
3— 150 H.P., Al. Ch. 1800 RPM. 2300V., 3PH. 60 Cy.

Large Stock of A.C. and D.C. Equipment

WHAT'S NEW AT BRISTOL . . . WHAT'S NEW AT BRISTOL . . .

Continuous Standardization

with no dry cells



...in BRISTOL Electronic Dynamaster Potentiometers and Pyrometers

- **CONTINUOUS STANDARDIZATION** eliminates need for dry cells—supplies voltage that is continuously compared with standard cell.
- **CONTINUOUS OPERATION—NO TIME OUT.** With continuous standardization, the potentiometer is free to continuously measure, record, and control. No time out or interruption is required for periodic standardization.
- **NO STANDARDIZING MECHANISM.** Continuous standardization is taken care of electrically. There is no standardizing mechanism.

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BRISTOL

THE DEPENDABLE GUIDEPOST OF INDUSTRY

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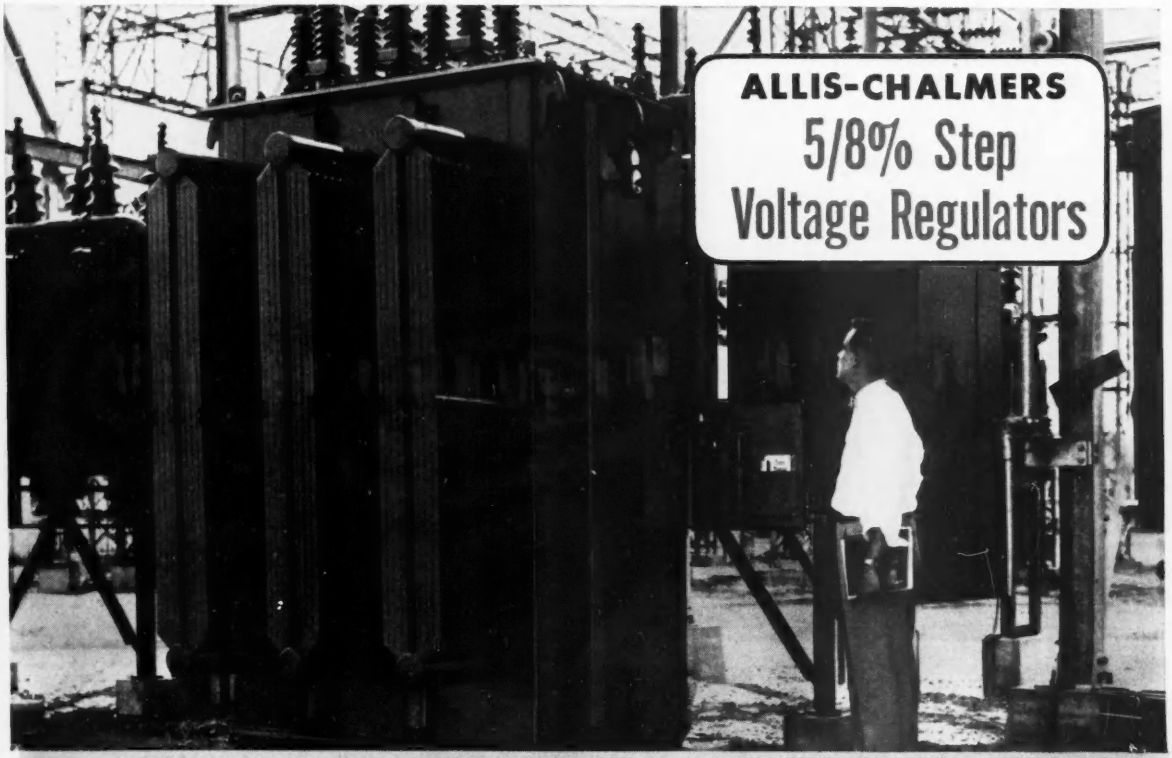

Simple Design Reduces Costs of Three-Phase Voltage Regulation

The simple design of Allis-Chalmers three-phase power regulators means you get highest quality regulation with an absolute minimum of maintenance. You get ± 1 volt band, Class I accuracy, 20% range of regulation, and many famous Allis-Chalmers features that cut costs.

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Thanks to unit construction, there are 78 fewer connections than with other designs. And all connections can be made before the unit is tanked. Untanking for future inspection is especially easy — just remove cover and control cabinet bolts, and lift entire regulator from tank.

Feather-Touch Control Easy to Operate

You save maintenance time with Allis-Chalmers voltage regulators because the *Feather-Touch* control has fewer operating components than any other regulator control. Operation is easy because control components are calibrated. Voltage band and voltage level can be set in less than a minute.

Quick-Break Tap-Changing Mechanism

Fast, efficient tap changing without shock, thanks to the balanced spring operation of the *Quick-Break* tap-changing mechanism, makes contacts last longer. Mechanism operates entirely under oil — there are no adjustments to make, nothing to lubricate.

It pays to get all the facts. Contact your nearby A-C office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

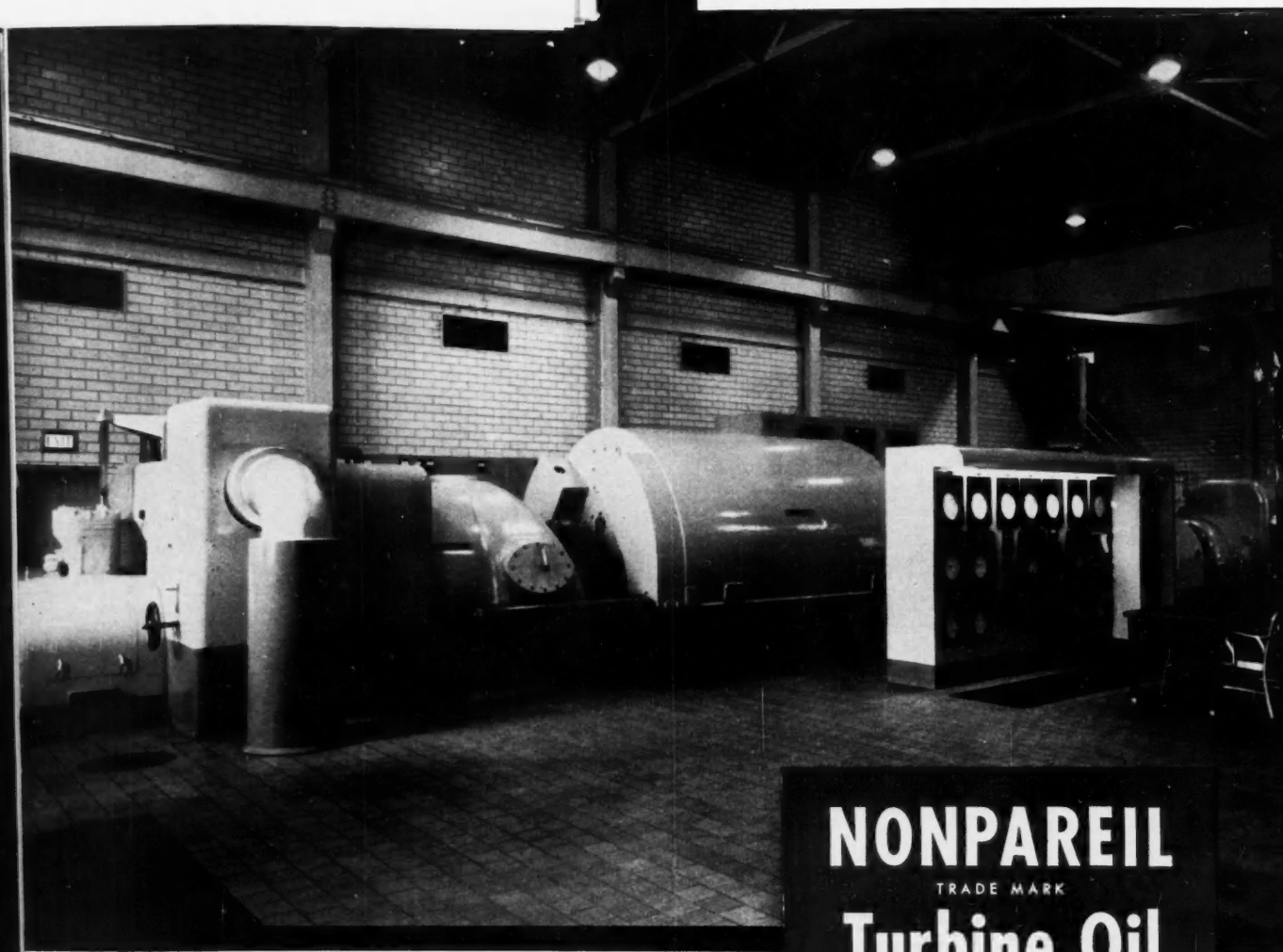
A-4128

Ratings Available	Through 2500 Kva Up to and Including 69 Kv

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Originators of ⅝% Step Regulation



Nothing succeeds like service!

● This turbine, one of the largest industrial units in the Midwest, was recently installed by a leading paper mill. The decision of mill officials to lubricate the new turbine with NONPAREIL Turbine Oil was based on their own experience with this outstanding product.

Beginning in 1941 in one unit, NONPAREIL has since been put into additional turbines; and, today, it lubricates all turbines in this big mill. Over the period of 12 years, it has not been necessary to replace any of the original fills of NONPAREIL because of lubricant deterioration or lubrication trouble. Oil systems have stayed clean. Oil acidity has stayed below 0.07 mg. KOH/gm.

In this mill, as in power plants throughout the Midwest, NONPAREIL has sold itself into one turbine after another. That success has been the result of superior turbine lubrication service. Service records of NONPAREIL cover up to 25 years' continuous operation of individual units on original fills of oil. Moreover, this unique lubricant carries a written guarantee that it will last as long as the turbine it lubricates and that its neutralization number will stay below 0.15 mg. KOH/gm.

The Standard Oil lubrication specialist serving your section of the Midwest will be glad to show you lubrication records of NONPAREIL in installations similar to your own. You can contact this specialist by phoning your local Standard Oil office. Or, write: Standard Oil Company (Ind.), 910 S. Michigan Ave., Chicago 80, Illinois.

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